3-5 Sounding Survey and Topographic Map

3-5-1 Sounding Survey

In January 1989, a sounding survey was carried out in waters outside the Port of Colombo as part of the feasibility study activities. This survey produced generally satisfactory results. The latest sounding map of the harbor basin has been complied from available sounding data. Figs.3-5-1 and 3-5-2 show the sounding maps of both the outer and inner harbors of the ports.

Fig.3-5-3 is a representative profile of the shore immediately south of the port which is based on a topographic survey performed along the shoreline in December 1989. Further details of the topographic survey data are presented in the Supplement.

The sounding and topographic survey data are utilized for the sand drift analysis undertaken during the feasibility study.

3-5-2 Topographic Map

Reconnaissance trips were made to different parts of the port area and the marshland behind the port to gain firsthand information on the actual land use conditions of the areas surveyed.

The results of the reconnaissance have been incorporated in the relevant topographic maps to update them. The new data incorporated include the actual use and external views of buildings and other structures located in the surveyed areas.

Figs.3-5-4 and 3-5-5 and Table 3-5-1 and 3-5-2 outline the results of the reconnaissance.

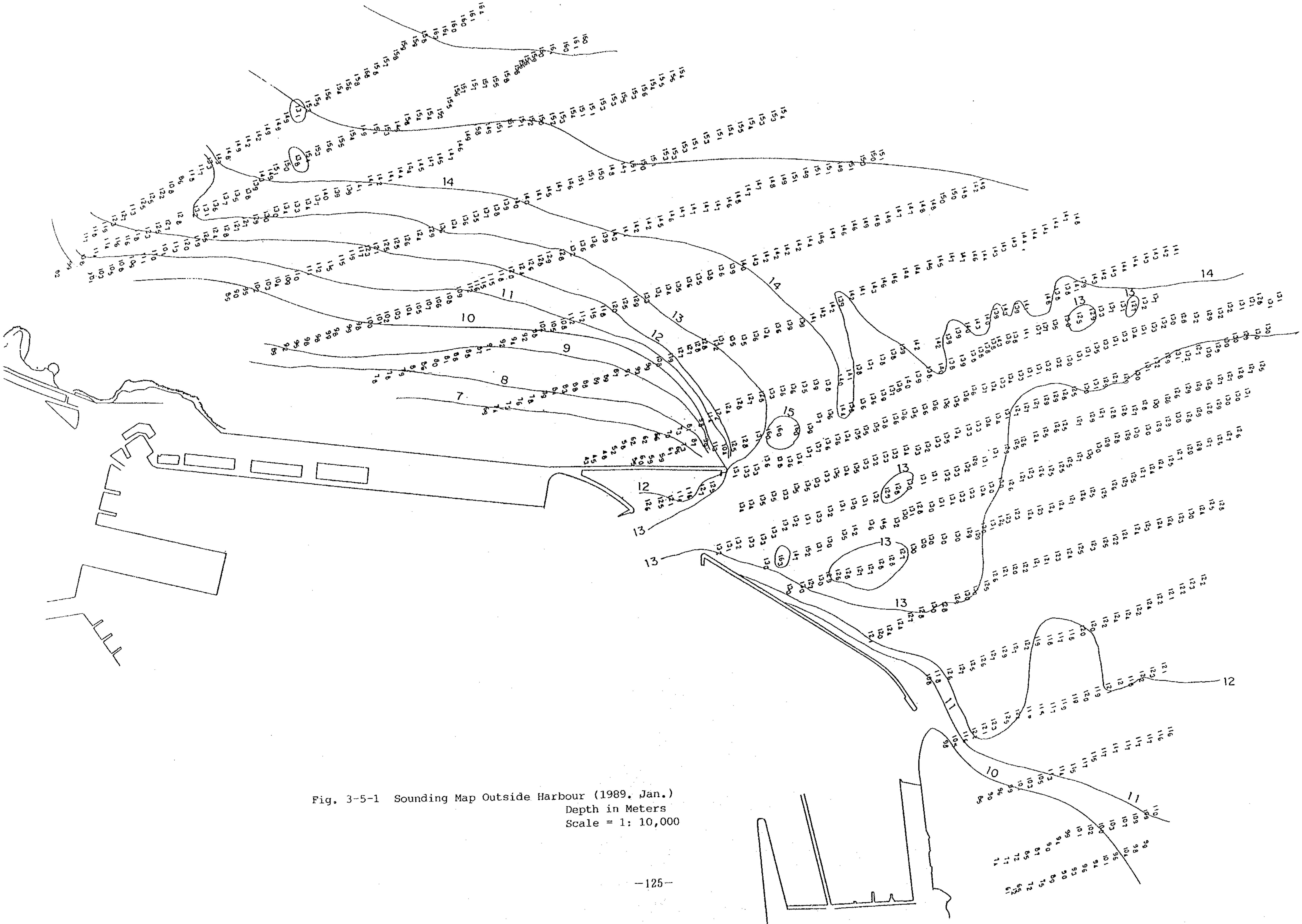


Fig. 3-5-1 Sounding Map Outside Harbour (1989. Jan.)
Depth in Meters
Scale = 1: 10,000

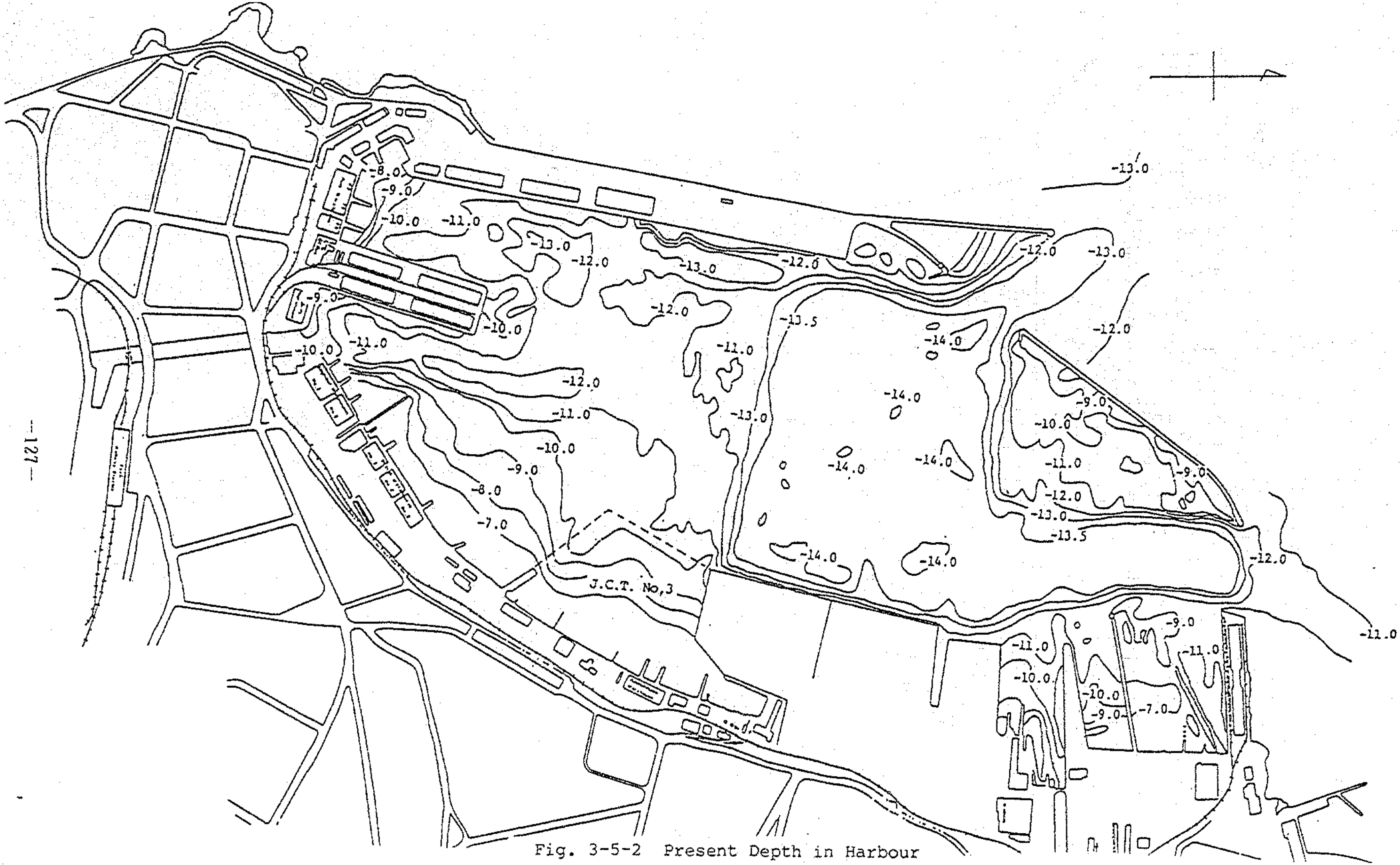


Fig. 3-5-2 Present Depth in Harbour (1988) Depth in meters

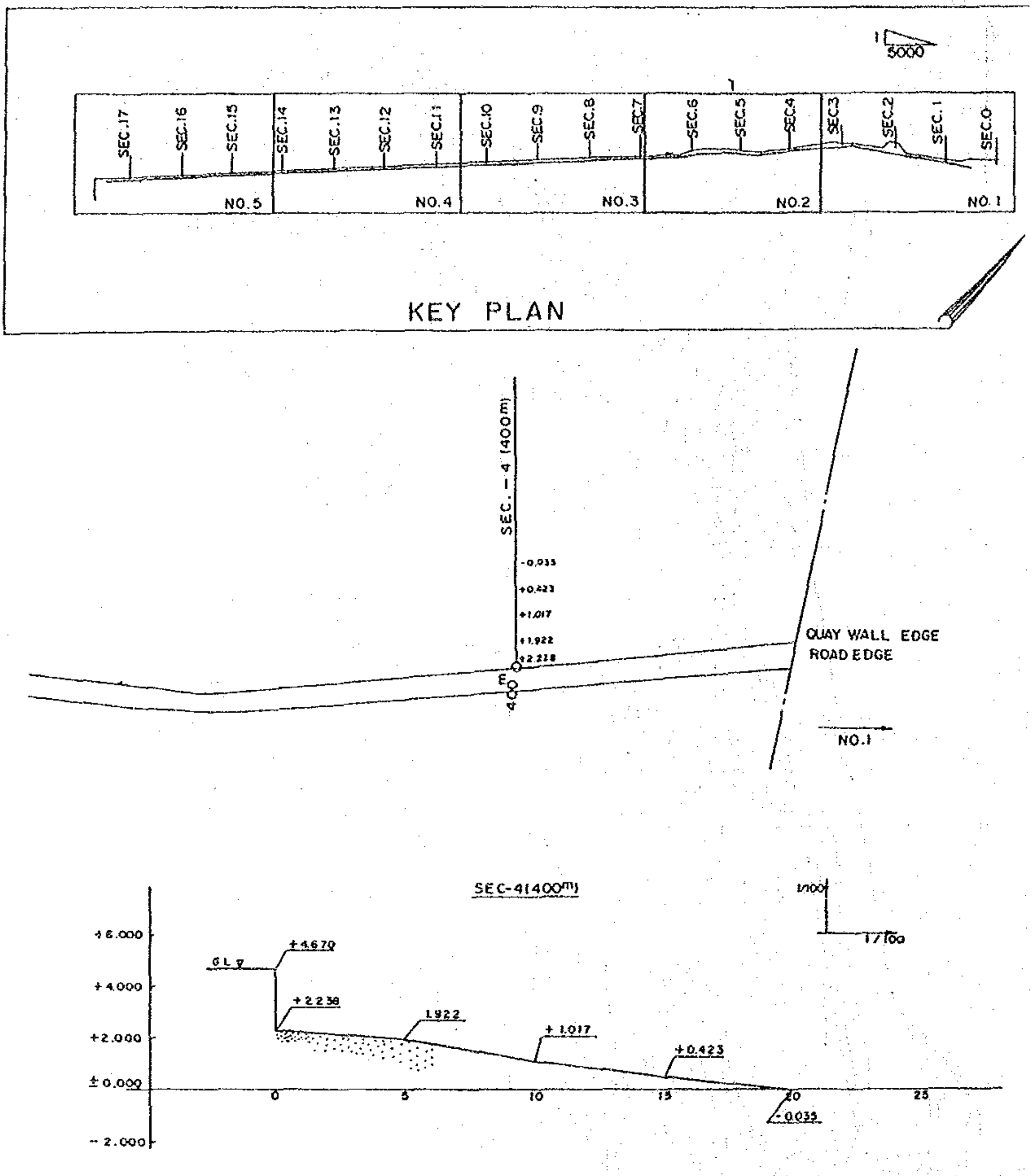


Fig. 3-5-3 Cross Section of Galle Face Beach

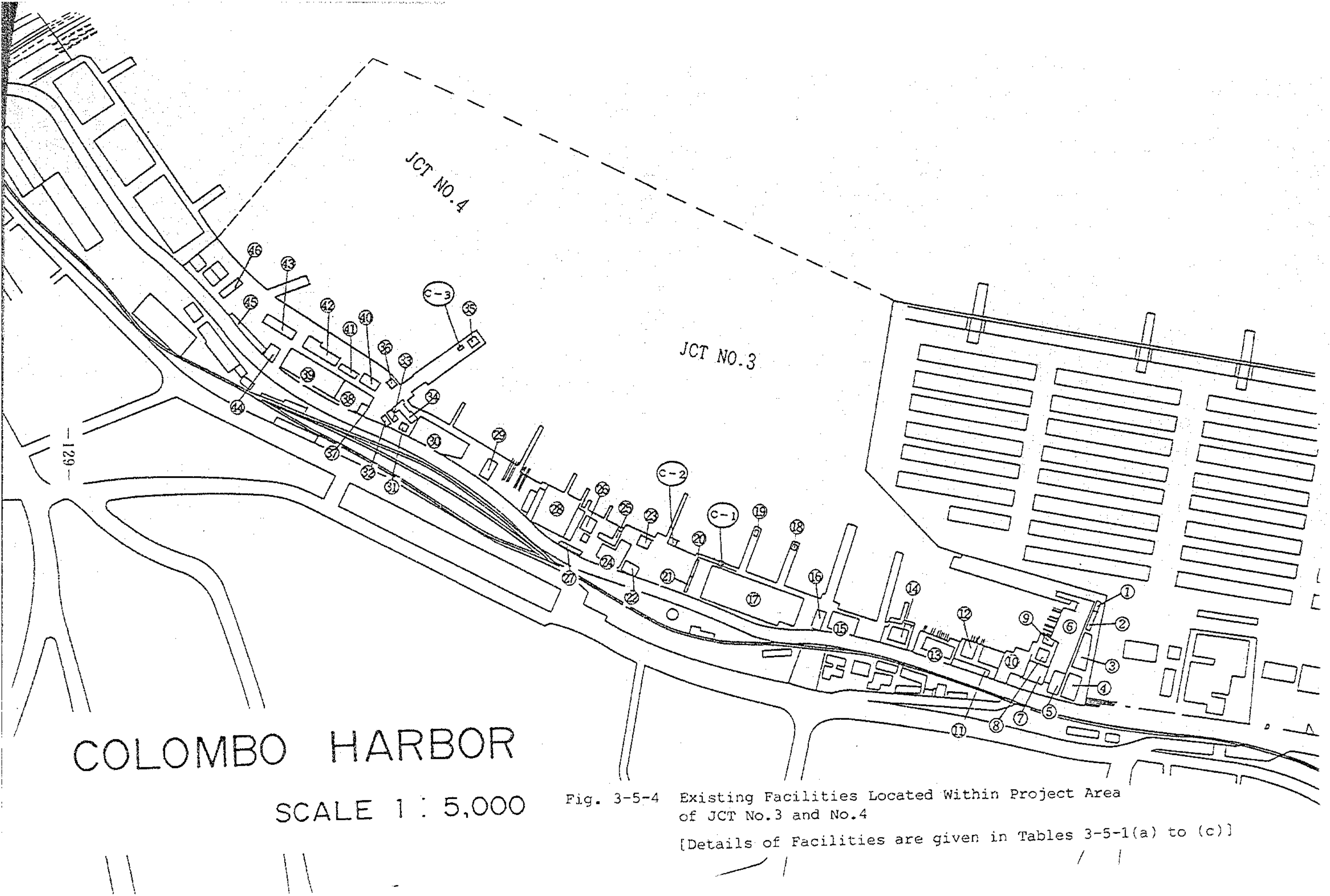
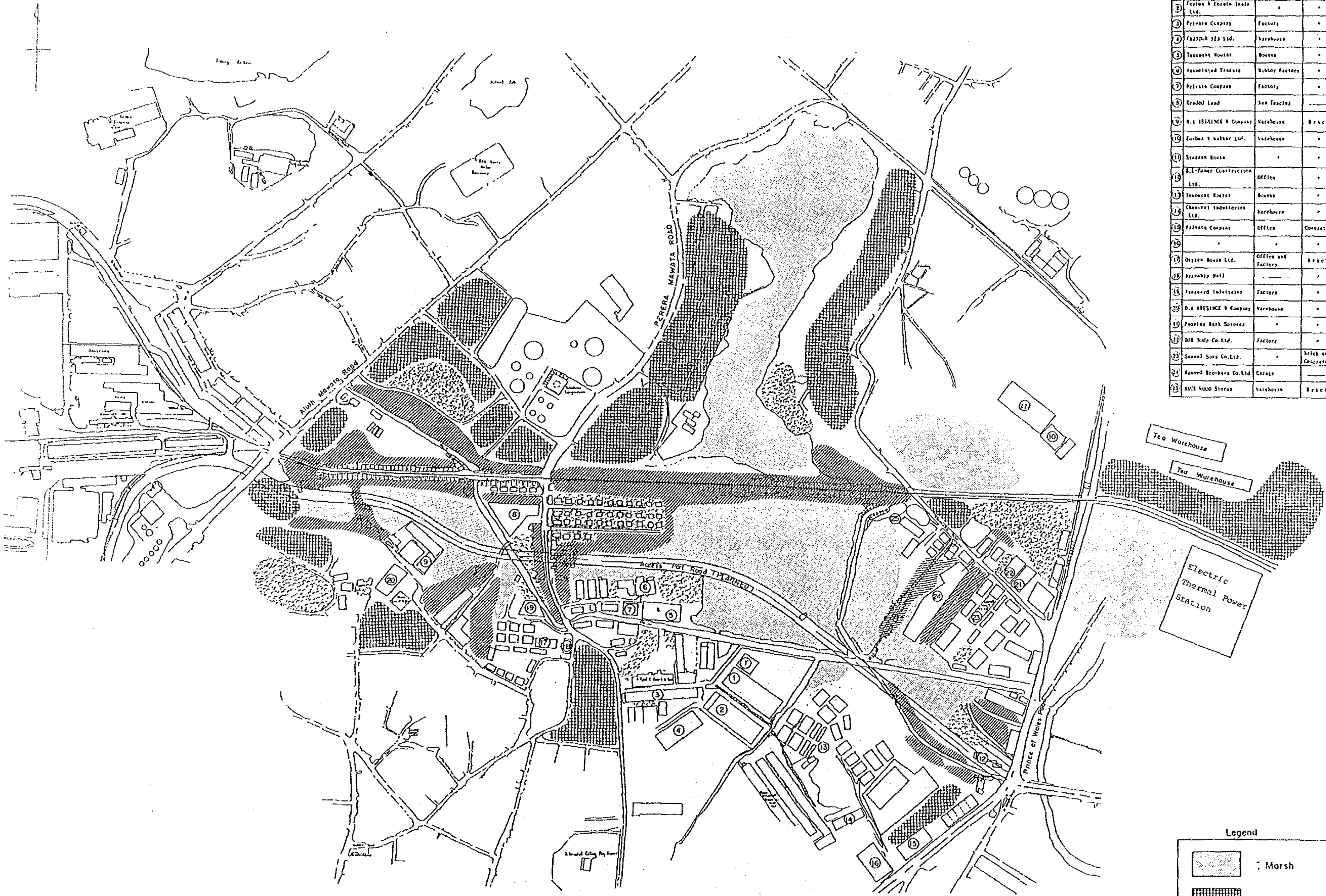


Fig. 3-5-4 Existing Facilities Located Within Project Area of JCT No.3 and No.4

[Details of Facilities are given in Tables 3-5-1(a) to (c)]



No	Facilities	Classification	Main structure	Roof	Story	Building Space	Built	Remarks
①	ERICO Ltd.	Warehouse	Brick	Zinc roofing	2	124.5m × 23.5m	1885	Old building ⑫Custom office
②	Ceylon & Foreign Trade Ltd.	〃	〃	Slate roofing	1	124.5m × 37.0m	1970	Good condition Tea store
③	Private Company	Factory	〃	〃	1	45.5m (Width)	1880	Poor structure Tea box producing
④	CALTOUR TEA Ltd.	Warehouse	〃	〃	1	——	1968	Old building Tea store
⑤	Tenement Houses	Houses	〃	〃	1	15m × 30m	1888	Old building
⑥	Associated Traders	Rubber Factory	〃	〃	1	35m × 15m	1883	Old building
⑦	Private Company	Factory	〃	〃	1	——	——	Old building
⑧	Graded Land	Bus Parking	——	——	——	2,250m²	——	
⑨	D.A. ABESINGE & Company	Warehouse	Brick	Slate roofing	1	90m × 70m (Land area)	1978	Rather good structure Tea and Rubber
⑩	Forbes & Walker Ltd.	Warehouse	〃	Tile roofing	1	——	——	Old building Tea and Rubber
⑪	Station House	〃	〃	Slate roofing	3	——	——	Old building Export Company Coconut, Rubber, Tea
⑫	D.L-Power Construction Ltd.	Office	〃	Zinc roofing	2	22.5m × 17.5m	1938	Old building Building owner; Broadway Batchalyer
⑬	Tenement Houses	Houses	〃	Slate roofing	1	5m × 5m (For one House)	1924	217 Houses
⑭	Chemical Industries Ltd.	Warehouse	〃	〃	2	52m (Width)	1965	Rather good structure
⑮	Private Company	Office	Concrete	Concrete roofing	4	——	——	〃
⑯	〃	〃	〃	〃	3	——	——	〃
⑰	Oxygen House Ltd.	Office and Factory	Brick	Concrete roofing	2	——	——	〃
⑱	Assembly Hall	——	〃	Slate roofing	1	——	——	Old building
⑲	Vanguard Industries	Factory	〃	〃	1	35m × 55m	1973	Old building Spinning mill
⑳	D.A. ABESINGE & Company	Warehouse	〃	〃	1	——	1970	Tea
㉑	Peoples Bank Stores	〃	〃	Concrete roofing	2	——	——	Old building
㉒	Oil Soap Co.Ltd.	Factory	〃	〃	1	40m × 15m	1963	Old building
㉓	Samuel Sons Co.Ltd.	〃	Brick and Concrete	Slate roofing	1	240m × 50m (Land area)	1968	Old building
㉔	Ahamed Brothers Co.Ltd	Garage	——	——	——	20m × 150m	——	
㉕	RICE KUDO Stores	Warehouse	Brick	Slate roofing	1	60m × 60m	——	Old building

Legend

: Marsh

: Houses

: Shonties

: Bush

Fig. 3-5-5 Land Use Plan in Crown Land (1989. Jan.) Scale; 1/8,000

Note; Details of facilities are given in Table 3-5-2

TABLE 3-5-1(a) Details of Existing Facilities Located Within The Project Area of JCT No.3 and No.4

(1/3)

No.	Facilities	Classification	Main-Structure	Roof	Story	Building Space	Remarks
①	Store	Store Warehouse	Brick	Slate roofing	2	(m²) 60	• Good condition
②	〃	〃	〃	〃	2 and 1	125	• 〃
③	〃	Store and Electric Sub-Station	R.C. and Brick	Concrete roofing	2	527	• 〃 (B-Section)
④	Engineering Managers Office	Office and Warehouse	Steel frame and Sheet zinc	Slate roofing	2	480	• Rather good condition
⑤	Cargo Craft Section	Office and Work shop	Steel frame and P.C girder	〃	2	273	• Good condition
⑥	Work Shop	Work shop and Office	Steel frame	〃	1	2,250	• Old building
⑦	Work Shop and Office	〃	Steel frame and Brick	〃	1	484	• 〃 • Waiting room
⑧	Store	Store	Steel frame and Brick	〃	2	169	• Poor structure
⑨	Shed	Shed	Steel frame and Sheet zinc	Zinc roofing	1	84	• Old building • Chips of wood
⑩	Shed	Shed	Steel frame	Slate roofing	1	1,284	• Rather good condition • Steel pipe and Steel bar
⑪	Shed	Store and Waiting room	Steel frame and Wooden wall	Slate roofing	1	390	• Old structure • rope
⑫	Repairshop	Slipway	Steel frame	Slate roofing	1	224	• Rather good condition
⑬	〃	〃	〃	〃	〃	1,000	• Good condition
⑭	NAVY	Office	R.C. and Brick	Slate roofing '	3	780	• Good condition • under extension of port
⑮	Base Engineering Work Shop	Work shop	Steel frame and Sheet zinc	Slate roofing	1	690	• Rather good condition
⑯	Kitchen (S.L.P.A)	Kitchenet	Brick	Slate roofing	1	253	• Rather good condition • Waiting room
⑰	Kochchikade Warehouse	Warehouse	Steel frame and Brick	Slate roofing	1	4,000	• Rather good condition
⑱	Hut	Waiting room	Wood	Steel zinc	1	25	• Good condition • Meeting room and Waiting room
⑲	Hut	Waiting room	Wood and Brick	Slate roofing	1	25	• Rather good condition
⑳	Custom Officer Kochchikade W. house SRI LANKA Customs	Office	Brick	〃	1	90	• Rather good condition

TABLE 3-5-1(b) Details of Existing Facilities Located Within The Project Area of JCT No.3 and No.4

(2/3)

No.	Facilities	Classification	Main-Structure	Roof	Story	Building Space	Remarks
㉑	Marine Engneer-ing Office	Office	Brick	Slate roofing	1	(m^2) 80	• Rather good condition
㉒	Fumigation Office	〃	Wood and Brick	〃	2	220	• Good condition
㉓	Warehouse	Warehouse	Brick	Tile roofing	1	60	• 〃
㉔	Fire Station	Office and Garage	R.C.	R.C.	2	660	• New building (1983, May)
㉕	Yacht Boat house	Boat house	Wood	Slate roofing	1	240	• Rather good condition
㉖	Yacht Club house	Club house	Wood and Brick	〃	1	240	• Good condition
㉗	Garage	Garage	Wooden frame and Slate	Slate roofing	1	180	• Old building
㉘	New Boat house	Work shop and Slipway	R.C. Concrete	Slate roofing P.C. Girder	1	2,370	• Rather good condition
㉙	Ship Wright Office - Block Jetty	Office	Wood	〃	1	264	• 〃
㉚	Repairshop	Slipway	P.C.	〃	1	1,575	• 〃
㉛	Generator Shop	Shop	Brick	〃	2	72	• 〃
㉜	Shed	Shed	〃	〃	1	39	• 〃 • Largesize fender
㉝	Boiler Shop Field - 1 Section 19	Boiler Shop	Brick	〃	2	105	• Rather good condition
㉞	Electric Shop and SLPA Office	Shop and Office	〃	〃	2	260	• Good condition
㉟	Tide Station	Office	〃	R.C.	3	50	• Rather good condition
㊱	Office	Office	Wood and Brick	Slate roofing and Tile roofing	1	120	• 〃
㊲	Garage	Garage	Block	Slate roofing	1	50	• Good condition
㊳	Store	Store	Steel frame and Steel mesh	〃	1	760	• Old building • Wood and Veneer board
㊴	Carpenter Shop	Factory	Steel frame and Block	〃	1	1,750	• Good condition
㊵	Work Shop	Work shop	Steel frame and Brick	〃	2	230	• 〃

TABLE 3-5-1(c) Details of Existing Facilities Located Within The Project Area of JCT No.3 and No.4

(3/3)

No.	Facilities	Classification	Main-Structure	Roof	Story	Building Space	Remarks
41	Shed	Shed	Wood	Slate roofing	1	(m^2) 160	• Old building
42	CHS	Office and Store (Surveyors)	R.C.	R.C.	2	462	• Rather good condition • Movement of Surveyers
43	WCS Building	Office	R.C.	Precast concrete	2	430	• Good condition
44	Rest room	Mess	Wood and Block	Slate roofing	1	200	• Rather good condition
45	Log Store	Store	Steel frame	〃	1	370	• Good condition
46	Store	Store and Work Shop	Steel frame and R.C.	Slate roofing	2	170	• Rather good condition
C-1	Wharf Crane	Crane					6 Tons at 60 Ft Radius. (1944)
C-2	Level Luffing Crane No. 126	Crane					(1941)
C-3	Level Luffing Crane	Crane					6 Tons at 60 Ft Radius. (1944)

TABLE 3-5-2 Details of Existing Facilities in Crown Land

NO	Facilities	Classification	main-structure	Roof	Story	Building Space	Built	Remarkes
①	TRICO Ltd.	Warehouse	Brick	Zinc roofing	2	124.5m× 23.5m	1988	New building ①Custom office
②	Ceylon & Forein Trade Ltd.	〃	〃	Slate roofing	1	124.5m× 37.0m	1978	Good conditions Tea store
③	Private Company	Factory	〃	〃	1	82.5m (Width)	1980	Poor structure Tea Box producing
④	CHATOOR TEA Ltd.	Warehouse	〃	〃	1	——	1968	Old building Tea store
⑤	Tenement Houses	Houses	〃	〃	1	45m×30m	1988	New building
⑥	Associated Traders	Rubber Factory	〃	〃	1	35m×15m	1983	Old building
⑦	Private Company	Factory	〃	〃	1	——	——	Old building
⑧	Graded Land	New fencing	——	——	——	2,890m²	——	
⑨	D.A ABESINGE & Company	Warehouse	Brick	Slate roofing	1	90m×70m (Landarea)	1978	Rather good structure Tea and Rubber
⑩	Forbes & Walker Ltd.	Warehouse	〃	Tile roofing	1	——	——	New building Tea and Rubber
⑪	Stassen House	〃	〃	Slate roofing	3	——	——	New building Export Company Coconut,Rubber,Tea
⑫	B.L-Power Construction Ltd.	Office	〃	Zinc roofing	2	22.5m× 12.5m	1938	Old building Building owner; Broadway Automotiue
⑬	Tenement Houses	Houses	〃	Slate roofing	1	9m×5m (per one house)	1984	217 Houses
⑭	Chemical industories Ltd.	Warehouse	〃	〃	2	68m (Width)	1983	Rather good structure
⑮	Private Company	Office	Concrete	Concrete roofing	4	——	——	〃
⑯	〃	〃	〃	〃	3	——	——	〃
⑰	Oxygen House Ltd.	Office and Factory	Brick	Concrete roofing	2	——	——	〃
⑱	Assembly Hall	——	〃	Slate roofing	1	——	——	Old building
⑲	Vanguard Industries	Factory	〃	〃	1	35m×55m	1973	Old building Spinning mill
⑳	D.A ABESINGE & Company	Warehouse	〃	〃	1	——	1978	Tea
㉑	Peoples Bank Sotores	〃	〃	Concrete roofing	2	——	——	Old building
㉒	DIK Mody Co.Ltd.	Factory	〃	〃	1	40m×15m	1963	Old building
㉓	Samuel Sons Co.Ltd.	〃	Brick and Concrete	Slate roofing	1	240m×50m (Landarea)	1968	Old building
㉔	Hameed Brothers Co.Ltd.	Garage	——	——	——	20m×150m	——	
㉕	MACK WOOD Stores	Warehouse	Brick	Slate roofing	1	60m×60m	——	Old building

3-6 Sand Drift

As is evident from Figs.3-3-1 (1) to 3-3-1 (5), wave energies in the offshore area of the Port of Colombo travel from south to north during the SW monsoon season and from north to south during the NE monsoon, and the travel of wave energies from south to north prevails all the year round.

In the port, nearly all waves approaching the coasts are broken over reefs found near the shorelines and at locations some 1km offshore of the north and south shorelines and the breaking waves travel onward in a direction nearly perpendicular to the shoreline. In consequence, sand drift in the shore direction tends to be reduced.

In the vicinity of jetties and smaller headlands, however, the south shoreline projects slightly farther out into the sea than the north shore, Near Kollapitiya Station about three km south of the port, the shoreline recedes to the immediate vicinity of the railway tracks. Rubble work is built along the shore to protect it against further erosion.

The shore at Galle Face immediately south of the port is protected by a revetment. During the NE monsoon season a sand beach is formed in this area, but it almost disappears during the SW monsoon season and there seems to be sand drift in both inshore and outshore directions.

The bulk of material from Kelani Ganga flowing into the shore area about two km north of the port moves northward and small sand dunes are formed on the shore leading to Negombo.

Fig.3-6-1 compares depth contour lines in the neighborhood of the harbor entrance. Almost no change is observed in the bottom configuration of the sea area north of the harbor entrance. On the west of the Southwest Breakwater the -10m contour line shifts slightly offshore and a tendency toward shoaling can be observed. This tendency may include a certain amount of shoaling produced by seasonal changes in the amount of sand drift in both inshore and outshore directions.

The year in which the chart was complied remains unknown, but if the contour line changes represented by Fig.3-6-1 have actually taken place over a period of 40 to 50 years, then the amount of sand drift responsible for the contour changes is not very significant. The contour lines for -13m and greater depths show almost no change. From these considerations it may safely be presumed that an extension of the existing breakwater to a depth of 13m or more may serve to reduce the shoaling process at the harbor entrance to a negligible level.

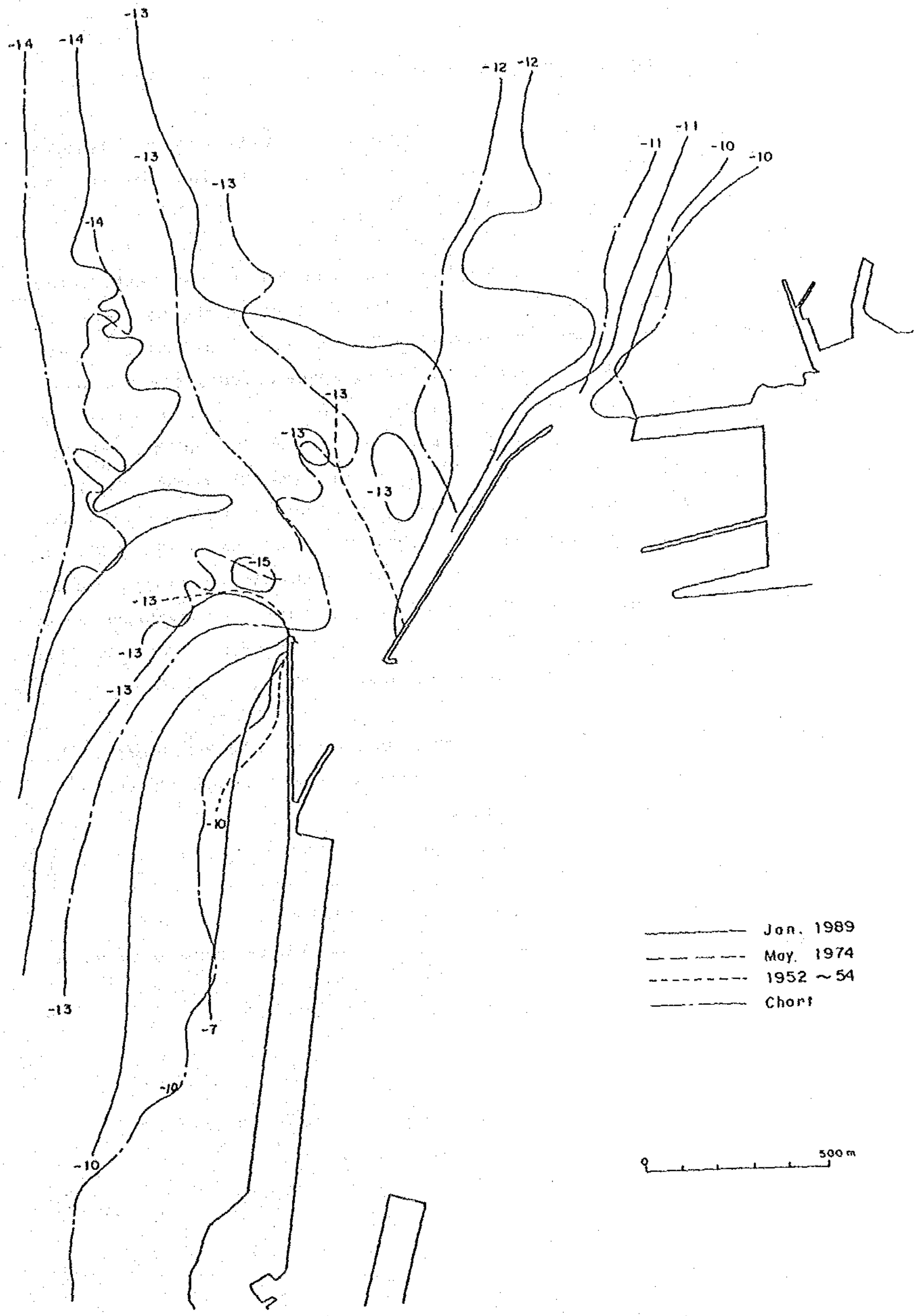


Fig. 3-6-1 Changes in Depth Contour Lines

3-7 Natural Environment of the Port Colombo

The air, water, bottom material, noises, vibrations and offensive odors are among the potential factors contributing toward the environmental pollution of the Port.

The influences of noises and vibrations produced by port activities upon the adjoining urban areas are negligible because the port area is located at an elevation lower than that of the surrounding urban areas and is also shielded by high brick walls. Nevertheless, the seawater, bottom material and offensive odors may affect the port environment in the future. Water in the port circulates to some extent through the two harbor entrances under the influence of tidal currents. The port area does not pose immediate serious environmental problems with the exception of the southern part of the harbor where the existing small-craft basin and the channel with a gate are contaminated appreciably with organic sludge deposits on the bottom. Visual observations made during the feasibility study suggested that the major causes of the contamination of this area are as follows:

(1) Organic sludge and wastes discharged from vessels, smaller craft, offices and other shore facilities including kitchens where meals for port workers are prepared.

(2) Municipal wastes produced by the adjoining urban areas.

The contamination in the south harbor area should be studied in depth with a view towards improving the situation.

3-8 Others

3-8-1 Tidal Levels

Tidal observations are made at a station located at the tip of Block Jetty. However, no harmonic analysis has been undertaken to obtain tidal components.

According to the Indian Tide Table (Geodetic and Research Branch, India) the tidal levels in the Port of Colombo are as follows:

Mean High Water Springs	+0.77 m
Mean High Water Neaps	+0.48 m
Mean Seal Level	+0.43 m
Mean Low Water Neaps	+0.30 m
Mean Low Water Springs	+0.11 m
Mean Low Lowest Water Spring	+0.02 m

3-8-2 Rainfall

During the 1978-1987 period, annual rainfall in Colombo varied from 1,500mm to 2,500mm, averaging 2,089mm as shown in Table 3-8-1.

The average monthly rainfall also varied from 70mm to 320mm and rainfall concentrates in the transitional periods between the monsoons and in the early and late parts of the monsoon seasons with precipitaion at 310-320mm. Maximum monthly rainfall has exceeded 50mm in the last 10 years and this figure accounts for 1/5 to 1/4 of the annual rainfall, and the maximum daily rainfall recorded in the past is 194.1mm.

Further, the number of rainfall days is about 156 days per year and the monthly rainfall days is less than 20 days.

TABLE 3-8-1 Rainfall at Colombo

Year	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1978	I	6.2	11.3	147.0	151.3	565.1	110.1	87.7	27.9	103.1	187.0	387.1	170.6	1954.4
	II	4	5	8	12	24	17	12	9	13	17	16	11	148
	III	2.4	6.1	6.1	72.2	38.3	16.2	46.2	8.6	33.3	35.6	70.3	49.7	124.1
1979	I	3.2	124.8	71.9	225.8	143.0	244.0	111.7	50.5	453.7	254.5	466.9	294.6	2450.6
	II	3	6	6	12	11	21	17	7	25	19	25	14	166
	III	2.2	71.5	36.7	97.0	64.6	40.1	24.4	21.5	66.4	57.7	111.4	59.7	111.4
1980	I	0.6	0	29.9	228.1	214.8	277.9	35.7	141.5	176.2	451.9	267.0	172.3	1995.9
	II	1	0	4	21	17	18	10	20	12	15	20	10	148
	III	0.6	0	11.2	70.9	47.8	71.0	15.7	38.3	50.1	73.1	69.0	79.6	79.6
1981	I	117.4	93.3	102.5	199.7	441.3	182.4	34.5	79.9	120.7	193.1	460.2	54.1	2079.1
	II	4	7	9	15	21	17	9	12	19	18	17	8	156
	III	75.3	41.7	49.2	52.5	124.0	51.2	15.3	22.5	26.9	48.0	153.3	17.1	153.3
1982	I	4.1	0.2	311.8	108.8	323.7	195.0	160.9	123.6	104.9	186.6	434.9	51.0	2005.5
	II	2	1	12	12	16	21	20	13	15	19	22	8	161
	III	3.3	0.2	154.7	33.1	98.1	33.3	45.5	40.7	29.1	34.4	51.3	34.7	154.7
1983	I	0	43.0	60.3	83.0	336.5	118.6	163.1	94.0	291.5	94.8	241.7	223.6	1750.1
	II	0	2	2	5	20	21	15	13	25	13	11	17	144
	III	0	39.5	57.9	46.7	194.1	26.9	26.7	19.8	49.3	39.3	72.7	64.5	194.1
1984	I	211.5	179.6	162.5	254.0	191.0	176.8	127.8	4.9	339.3	161.3	360.1	24.2	2493.1
	II	16	14	14	20	24	20	17	4	11	16	20	3	179
	III	54.4	98.0	41.8	48.2	98.5	36.3	23.6	3.0	109.8	29.5	91.6	12.8	109.8
1985	I	83.5	160.8	116.1	76.3	253.1	316.9	19.6	111.2	275.7	343.4	244.9	230.9	2232.4
	II	10	8	10	9	14	24	10	9	18	19	14	13	158
	III	27.1	64.9	42.7	38.9	89.0	42.6	8.1	38.2	86.8	86.8	66.0	66.6	135.7
1986	I	144.9	78.4	81.4	216.8	230.9	63.8	10.5	76.2	128.4	163.0	58.9	203.4	1456.6
	II	7	4	10	18	12	15	6	8	16	21	10	14	141
	III	76.2	53.1	29.0	85.4	100.2	19.0	2.4	27.7	45.6	54.8	11.4	35.5	100.2
1987	I	98.4	0	73.2	179.3	198.4	116.3	12.0	404.8	508.9	506.5	217.4	136.0	2451.2
	II	8	0	9	15	12	14	4	23	18	25	19	10	157
	III	51.6	0	19.9	39.9	83.1	23.3	8.0	51.7	151.2	77.2	37.8	70.2	151.2
Mean	I	67.0	69.1	116.2	172.3	319.8	180.2	76.4	111.5	250.2	254.2	313.9	156.1	2086.9
	II	5.5	4.7	8.4	13.9	17.1	18.8	12.0	11.8	17.2	18.2	17.4	10.8	155.8
	III (Max)	76.2	98.0	154.7	97.0	194.1	71.0	46.2	51.7	151.2	77.2	153.3	79.6	194.1

Notes: I : Monthly Rainfall II: Number of rainy days III: Heaviest rainfall in 24 hrs.

3-8-3 Temperature

The mean annual temperature is 29°C., and the daily temperature varies by about 6°C with no major seasonal change.

3-8-4 Humidity

Humidity is relatively high and usually varies from 70% during the daytime to 90% at night.

3-8-5 Tidal Current

The tidal current off the Port of Colombo seldom exceeds 0.5 knot.

CHAPTER 4 INTERNATIONAL CONTAINER TRANSPORT AND THE PORT OF COLOMBO

4-1 The Way to Containerization in Colombo

The Vast area in the Indian Ocean between Singapore and the Suez, is now being seriously looked at by many reputable world-wide container operators. The port of Colombo is centrally located in this region and has a great geographical advantage in relaying the cargoes originating from and/or destined to this region. The Indian ports of Bombay, Cochin, Tuticorin, Madras, Calcutta and the Bangladeshi ports of Chittagong and Mongla are easily accessible from Colombo. So are the Gulf Ports, Karachi and the ports of East Africa. The ports central location along with its relatively high efficiency has led many container operators to choose Colombo as a base port to operate feeder services to many of the regional ports.

Containerization of seaborne transportation was introduced by major shipping operators of developed countries in the early 1960s and it came to Colombo a decade later. It was a foreign liner operator that pioneered the containerization of the routes as well as the operating of feeder services to and from Colombo. The lead was taken by American President Lines (A.P.L.) in 1973, to be followed in the early 1980s by other lines, the most important being Continental Britain Asia Container Service (COBRA), and Sri Lankan National Line, Ceylon Shipping Corporation (C.S.C). It is to the credit of the C.S.C that it made a significant contribution in the Sri Lankan efforts towards promoting containerization of the port and the routes in the region, while many other countries of the region with established shipping lines were too slow to react to the new technology in ocean transportation.

Established in 1969 as a joint shipping venture of government and private firms, C.S.C was taken over by the government and became a wholly owned state enterprise in 1971. During the 1970s, C.S.C. engaged in main trunk trade such as European and Far East trade by conventional fleets. A turning point, however, came in 1980 when C.S.C. inaugurated full container service for Europe in collaboration with the Neptune Orient line of Singapore (N.O.L.) deploying two 560 TEU container ships chartered from N.O.L. This was followed by a

CSC's Container Fleet

No.	Vessel's Name	When Built	Where Built	Cellular Not	Geared/ Gearless	TEUs	Refer TEUs
1.	"Lanka Amitha" *	1985	W. Germany	non-cellular	Geared	1,328	100
2.	"Lanka Abhaya" *	1984	W. Germany	non-cellular	Geared	1,328	100
3.	"Lanka Aruna" *	1983	W. Germany	cellular	Geared	1,074	71
4.	"Lanka Asitha" *	1983	W. Germany	cellular	Geared	1,074	71
5.	"Lanka Amila" *	1983	W. Germany	non-cellular	Geared	1,316	32
6.	"Lanka Siri"	1981	S. Korea	non-cellular	Gearless	175	4
7.	"Lanka Seedevi"	1981	S. Korea	non-cellular	Gearless	175	4
8.	"Lanka Srimani"	1982	S. Korea	cellular	Gearless	412	25
9.	"Lanka Srimathi"	1982	S. Korea	cellular	Gearless	412	25
10.	"Lanka Muditha"	1982	Japan	cellular	Geared	101	4
11.	"Lanka Mahapola"	1983	Japan	cellular	Geared	410	36
12.	"Lanka Athula"	1983	Argentine	cellular	Geared	537	50
13.	"Lanka Ajitha"	1985	Argentine	cellular	Geared	537	25

* Mark indicates time charter

second service linking Singapore and Colombo with Pacific International Line (P.I.L.) from 1982 onward. Then C.S.C. ordered new full container ships and multipurpose ships from Korea and Japan and purchased two 550 TEU vessels from Argentina.

The efforts of C.S.C. to containerize a wide network to and from Colombo were, to a great extent, assisted by the policies of Central Freight Bureau (C.F.B.) which is a governmental body founded in 1973 under the freight bureau law. Among other functions, C.F.B. holds authority to give loading rights for outbound cargoes from Sri lanka to shipping lines. This power functioned adequately to help C.S.C. invest in cellular vessels through greater allocation of cargo to its fleets and motivated the development of C.S.C's container fleet and services. Besides, the Bureau also gave preferential treatment in cargo allocation to foreign liners which pioneered the containerization of the East-West trade.

In the meantime, the Sri Lanka Ports Authority (S.L.P.A.) was established on 1st August 1979, combining three existing port organizations. The port (cargo) corporation, the Colombo Port Commission and the port tally and protective service corporation had no coordination until then. Sri Lanka is one of the few countries of Asia to foresee the possibilities of a container revolution as far back as the 1960s. However the construction of a container berth which was undertaken in 1964 was too slow, and faster progress was only made after the establishment of S.L.P.A. Besides, the port was poorly equipped to handle containers. The port (cargo) corporation had no specialized equipment for container operations, so A.P.L. which commenced the first service in 1973, brought its own equipment to this country. Towards the end of 1977 when Australian fully containerized ro/ro striders introduced a service between the Middle East and Australia they also had to use their own equipment. Both lines retained their equipment within the port premises. The lack of handling apparatus appeared to be greatest impediment for the quick despatch of vessels. To remedy this, SLPA in 1983 invested its own funds in two Liebherr Gantry Cranes and hired a Tango crane.

The unexpectedly high rate of growth of container traffic at Colombo in the late seventies made the expansion of container facilities imperative which has led to the construction of Jaye container terminals No. 1 and No. 2. Nowadays, Colombo has the most modern and integrated container facilities and equipment in this region. Besides, reliable work and simplified and flexible documentation coupled with competitive tariff rates have successfully attracted mainline container operators. Newcomers initiated additional services last year and another operator is expected to begin operations this year, although the increase of callers would present various problems to the port.

4-2 Container Operators Around Colombo

- Their Strategies and Activities -

There are various types of mainline vessels and feeder vessels handling containers in Colombo-fully cellular, partly cellular and non-cellular; gearless and geared; full container vessels combo-type, multipurpose-type and even conventional twin deckers engaging in container traffic. Brief profiles of selected lines are presented below.

American President Lines LTD

If would be impossible to talk about containerization at Colombo without referring to A.P.L. As mentioned in the preceding chapter. A.P.L. was the pioneer in this field, and it is no exaggeration to say that without A.P.L.'s pioneering activity, containerization at Colombo would not have advanced to its present stage. It is probably for this reason that A.P.L. has been given preferential treatment in the port and trade, though this may create adverse repercussions for various competing lines.

A.P.L.'s service patterns have changed since last fall and may change again in the future. Therefore it is best to review A.P.L.'s service chronologically.

A.P.L.'s mainline traders previously covered Colombo, Singapore and Kaohsiung, where all cargoes were transshipped to the U.S.A. However, from October 1988 onward, 3,060 TEUs were shifted to the U.S.A. via Japan in view of the congestion prevailing in the port of Kaohsiung. Colombo was a terminal port where all cargoes originating from/destined to ports between the Gulf and Madras were fed to/from Colombo. Sea Consortium's WAXL service had fed the Gulf and Karachi cargoes and Bombay and Cochin cargoes to Colombo on separate feeder services. BXCL had fed Madras cargoes to Colombo on its weekly shuttle. Only cargoes from/to the Upper Bay of Bengal ports were exceptionally fed to Singapore. However, an unhappy political disturbance which compelled the port closure in the middle of November 1988 had changed this established service route of A.P.L.'s. A mainline vessel and four dedicated feeder vessels under operations by Sea Consortium Pte Ltd., of Singapore (SEACON) were involved in this walkout and were detained in the port for 5.5days on average. A.P.L., therefore, decided to extend its mainline service to Fujairah (U.A.E) and in consequence, all Gulf and Karachi cargoes were placed outside of transshipment at Colombo.

From midnight of January 1st 1989. A.P.L. took over WAKL and six vessels were renamed with the prefix "EAGLE". A.P.L transferred their operations to a wholly owned subsidiary "EAGLE" container carrier (E.C.C.), and thus WAKL has become a dormant company.

At a recent meeting with Messrs. Julio Soares and Neil Eijheratne of A.P.L. it was understood that with the lessening of congestion at Kaohsiung terminals, A.P.L.'s mainline service will be restored and terminated at Kaohsiung. Four L-type vessels are deployed in this trade and running Kaohiung, Singapore, Colombo, Fujairah and vice versa in 28 days and providing weekly services. At the same time feeder networks will also be reorganized. In view of requirements to cover newly developing ports of India such as Visakhapatum, Tuticorin, Mangalore, Port Bumber, Kandla etc., The following new routes are now under study:-

West Coast of India - Colombo

One 250 TEU vessel with weekly service Colombo-Cochin-Tutucorin-Colombo

East Coast of India - Colombo

One 300 TEU vessel with fortnightly service Colombo-Madras-Vizagapatam-Colombo

West Coast of India - Fujairah

Two 545 TEU vessels with weekly service Fujairah/Port Bumber (export only) Bombay/Kandla (export only)/Fujairah.

Karachi cargoes will continue feeding to Fujiairah on a separate feeder and cargoes of the Upper Bay of Bengal ports will be fed to

Singapore in the same manner as at present.

Should these new service routes be actually introduced, Colombo would lose Bombay cargoes further. However, Mr. Soares was wondering if Fujairah could manage these increased volumes of transshipment cargo as they have only two gantry cranes.

The volumes lost to Fujairah are estimated at some 120,000 TEUs which are almost equivalent to half of A.P.L.'s total throughput. No single newcomer can make up for this volume. Therefore, the 1989 transshipment volume of Colombo would not grow appreciably. Though the port disturbance motivated A.P.L. to extend mainline vessels to Fujairah, this does not seem appropriate. Route changes should be a part of A.P.L.'s would-wide strategy as they seriously look at the future potential of the Gulf area. Otherwise A.P.L. may incur considerable deviation cost.

Yang Ming Line (Y.M.L)

Y.M.L. is a newcomer to Colombo, but is Y.M.L. a volume carrier from the beginning of November 1988. Its mainline vessels linking the Far East with the Red Sea/Mediterranean/U.K and the continent commenced direct calls at Colombo on a weekly basis in both directions. The trade is covered by its P-type (3,090 TEU) and "Sun" type (1,840 TEU) vessels.

However, from their inaugural call to Colombo, they met the disturbances prevailing in Colombo at that time. Their first Westbounder called at Colombo on November 4th, 1988. But the subsequent two callers scheduled for the 10th and 17th of November skipped Colombo. Thereafter two Westbounders called at Colombo on the 24th and 30th of November, but the subsequent two scheduled on 8th and 18th of December skipped Colombo. There after regular calls continued upon the port having returned to normal.

In the meantime, their Eastbounders skipped Colombo from the beginning. The first two vessels schedule on the 17th and 24th of December skipped and therefore the first Eastbounder called at Colombo on January 2nd 1989.

Previously Y.M.L. used Singapore as a feeder base port covering the Indian Subcontinent ports but they changed it as the shorter haulage between Colombo and the East and West Coasts of India reduces costs. Their projected throughput at Colombo is 18,000 TEUs in 1989 and 42,000 TEUs in 1991.

Evergreen Marine Corporation Ltd (E.M.C.)

E.M.C. is seriously looking at the Indian Subcontinent area including Colombo in recent days. Up to the present, all E.M.C.'s cargoes originating from/destined to this region are transshipped at Singapore. As E.M.C. does not have their own feeder service, they have been using common feeders such as Sea Consortium, Sindbad Lines, Bengal Tiger Lines, etc. The feeder areas to Singapore are very extensive and widely spread out-Karachi, Bombay, Cochin, Tuticorin, Madras, Calcutta and Chittagong.

However, E.M.C. has always met difficulty to secure adequate feeder spaces on common feeder carriers to/from Singapore. This is why E.M.C. made an experimental direct call at Colombo. On October 22nd 1988, E.M.C.'s first round-the-would liner "Ever Goods" with 3,400 TEUs called at Colombo for six hours stay at J.C.T. and discharged 190 TEUs of transshipment containers to I.S.C. destinations. But there has been no schedule of direct calls thereafter. E.M.C. has no marketing agent in Colombo yet and therefore no local cargo.

Whether or not E.M.C. commences regular direct calls at Colombo will be decided at E.M.C.'s Headquarters. The local agent this mission interviewed in Colombo is in no position to comment on this. Two days after "Ever Goods" called at Colombo, a staff member from the principal visited Colombo to investigate the port. During his stay in Colombo, he experienced the port disturbances. Apart form that, he was impressed that the port was congested with A.P.L.'s boxes and further, the port has given berthing priority to A.P.L.. A.P.L. and E.M.C. - if the latter calls at Colombo - have conflicting schedules, as A.P.L. is a weekly caller and E.M.C's mainline vessels call every 6 days, and therefore these two would inevitably hit upon on the same day and in consequence, there might be possible berthing delay on the part of E.M.C.. However, as A.P.L. has now set up a transshipment base port in Fujairah, the situation has changed. The round-the-world lines are covered by 14 fully cellular gearless vessels of the so-called E.M.C. G-type with 2,400 TEUs/2,800 TEUs of capacity and run at 20.5/20.7 knots of service speed.

A confidential but reliable source told the mission that E.M.C. will likely come to Colombo. E.M.C encountered a problem in respect of local representation. Al Qutub & Unicorn Lanka (Pvt) Ltd., is a foreign venture. The source said that E.M.C. is now recruiting agent staff in an attempt to form their own agent, like "Green Lanka Ltd". (Written in Feb. 1989, now E.M.C Vessels are scheduled callers, and there are marketing agents in Colombo, June, 1989)

Sealand

The port of Colombo has not been covered yet by the mainline loaders of Sealand. The Eastbound mainline loaders ply U.S.E.C., Europe and terminate their voyages at port Rashid (Dubai) under the consortium. The Westbound mainline loaders ply U.S.W.C., Far East ports and terminate at Singapore. Therefore, the huge area between the Gulf and Singapore has been left to a feeder area under the current operational pattern. Main line loaders are 2,500 TEU fully cellular, gearless container ships, serving on a weekly basis.

There are two Sealand feeder services on the Westbound trade in this area. M/s. "Carolina D" 550 TEUs cellular, self-sustained is covering Port Rashid, Colombo, Tuticorin and Cochin on two weeks' turnarounds providing bi-weekly service. M/s. "Silver Star" 410 TEUs cellular, self sustained is covering Port Rashid, Karachi and Bombay on bi-weekly service. All cargoes are fed to Port Rashid and transshipped to main line traders there. Cargoes originating from Madras and the Upper Bay of Bengal ports - Calcutta and Chittagong are fed to Colombo and transshipped to "Caroline D". This sub-reeder trade has been covered by common feeder operators - Sea Consortium (BXCL) and C.S.L. In the meantime, Eastbound cargoes for Far East and U.S.W.C are fed to

Singapore to connect to main line traders there. Under the agreement these cargoes are catered for by Mitsui O.S.K.'s feeder of 916/881 TEUs capacity. Two Ocean "S" type and one other M.O.L. feeder are serving on a 10 day basis between Singapore, Colombo, Karachi, Bombay, Colombo and Singapore.

As for the future's picture, according to a confidential source the Consortium will be disbanned in April 1989. In that circumstance, Sealand will be reorganizing the current service route of mainline trade, extending from Europe to Jeddah, Dubai, Karachi, Colombo and Singapore on Eastbound Trade and completing round the world service. 2,500 TEUs loaders will be employed and serve weekly services. Simultaneously the current feeder networks will also be reorganized. Two feeder routes will be operated by Sealand itself, one covering the Gulf and Cochin and the other covering Bombay, Cochin, and Colombo, thus almost all cargoes originating from the Indian Subcontinent will be fed to Colombo with the result of an annual increase of throughput of 40,000 TEUs (10% reefer Cargo).

Ceylon Shipping Corporation (C.S.C.)

The historical background of C.S.C. was referred to in the preceding chapter. C.S.C. is the second biggest volume carrier serving Colombo, next to A.P.L. While foreign shipping lines serve at most a couple of service routes, C.S.C., as the national line, is obliged to cover all trunk lines to/from Colombo. It operates six mainline container services for Europe, the Far East and Red Sea, the U.S.A. (A Joint Service with Mearsk), the East and West Coasts of Australia (A Joint Service with A.N.L.), and Singapore. Besides, it operates four feeder services covering the East and West Coasts of India, the Gulf and Upper Bay of Bengal Ports, under C.S.C.'s subsidiary company, Ceylon Shipping Lines (C.S.L.)

A characteristic of C.S.C. is that with the sole exception of its Far East Line, its fleets have been assigned to the Queen Elizabeth Container Terminal. It appears that there is a basic understanding among the parties concerned that the huge amount of investment in the Port should be amortized in foreign currencies by inviting Foreign

Shipping Lines to the new terminals. C.S.C.'s throughput for the next three years (1989-1991) are projected at 91,024, 96,604 and 102,654 TEUs, respectively.

Continental Britain Asia (COBRA) Consortium

COBRA Consortium is an old client of the Port. This Consortium, which was formed in 1981, is comprised of the following lines under the Slot Charter Agreement and traffic and operations are centrally controlled by COBRA Tonnage Center (C.T.C.) London and its focal centers established in the major ports en route.

P. & O. Container Ltd.	(P&OCL-United Kingdom)
Hapag-Lloyd Akitiesgessollache	(H-L - W. Germany)
Nedlloyd Line	(H-L - Holland)
Compagnie Generale Maritime	(CGM - France)
Compagnie Maritime Belge	(CMB - Belgium)

The four COBRA members other than C.M.B. extended their vessels ranging from 1,000 TEUs to 1,100 TEUs to C.T.C. to constitute the COBRA fleet. They are fully or partly cellular and geared container ships running one turnaround voyage - Eruope Karachi Colombo, Bombay Karachi Eurpoe in two months with 15 days frquency. They also operate their own feeders on a joint service with Ceylon Shipping Lines to feed cargoes between the Upper Bay of Bengal Ports/Madras and Colombo. In emergencies such as the disturbance to the Port Operations in Colombo last fall, COBRA mainline vessels substituted Cochin as a transshipment base port. There are discussions between COBRA and C.S.L. to feed Bombay to Colombo through a joint feeder service which may materialize toward the latter part of 1989, provided Colombo can re-establish reliability and guarantee service standard.

Euro-Asia Container (EACON) Service

The D.S.R. Lines of Rostock inaugurated a full container service from Europe to Colombo on 1st July 1986, and subsequently extended the services up to Japan deploying additional vessels. In order to expand the activities and to offer a better frequency in sailings, more vessels had to be deployed. Hence the D.S.R. Lines and Polish Lines of Gdynia agreed to operate jointly a fully integrated DSR/POL container service under an operating agreement for Euro - Asia - Container Service (EACON Service). The service commenced from July 1988 with nine full container gearless vessels ranging from 918 TEUs to 1,164 TEUs from DSR Lines and one full container gearless vessels of 1,633 TEUs from POL. Polish Ocean Lines is planning to supplement this service by the addition of two more vessels in the near future. From the inception, the D.S.R. Lines operations were carried out at JAYE Terminal and the Eacon Service too continues to operate at JAYE Terminal.

Between Suez and Singapore the Eacon Service uses only Colombo as a relay station except Khor Fakkan (U.A.E.) via which all Gulf Cargoes are fed. Mr. S.D.S. Gunasekara, Chairman of Ceylon Ocean Lines Ltd., which represents EACOM in Colombo told this mission that should his principals decide to leave Colombo, the transshipment operations to the Indian Subcontinent Ports and the Upper Bay of Bengal Ports could be done Without much hindrance from Khor Fakkan and Singapore as the line has experimented with this operation on a small scale. Ceylon Ocean Lines Ltd., also represents Odessa Ocean Container Service of Russia linking Black Sea ports and Mediterranean ports with South Asia with fully cellular and gearless container ships on 18 days frequency. This line calls regularly at Madras. Due to limited facilities at Madras, Madras could not induce many mainline operators but offers attractive concessions to the lines. Principals of two Eastern Block countries and Russia appear to have considerable dissatisfaction at the preferential treatment given to A.P.L. in respect of berthing allocation and the volume incentive rebate system.

United Arab Shipping Co., LTD. (U.A.S.C.)

U.A.S.C. is a shipping company established as a joint venture by six Arabian Countries - Iraq, U.A.E., Saudi Arabia, Kuwait, Bahrain and Quater. It operates two mainline container services linking the Far East and Southeast Asia with Gulf and Red Sea ports respectively. Both lines commenced serving Colombo in December, 1985 but the Gulf Line skipped Colombo since 1986 as no loading rights had been given to them by C.F.B. except for tea consignment to the Iraqi Government. At present, this parcel is covered by the Red Sea Lines and discharged at the Port of Aquaba. The Gulf Line employs six 2,000 TEU fully cellular and gearless container ships and the Red Sea Lines is covered by one 2,000 TEU and two 800 TEU cellular, gearless container ships.

Their throughput volumes recorded 12,260 TEUs in 1986 but the figure has since decreased due to the Gulf Lines having eliminated calls at Colombo.

Mitsui O.S.K. Lines LTD. (M.O.L.)

Despite their positive activities on world-wide container routes, Japanese container operators have very limited performance in this region. This is partly due to the small volume of container traffic to Japan from ports in the Indian subcontinent area and partly due to no loading rights given by C.F.B. for third countries. The terminal trade between Sri Lanka and Japan has been covered by conventional charter vessels with a small container capacity or Colombo has been covered as wayport trade by their Far East-East Africa-South America Multipurpose liners.

However, the situation has gradually been changed since M.O.L. inaugurated "South Sea Container Service" from March 1988. Two 916 TEU geared multipurpose type vessels run Singapore, Colombo, Karachi, Bombay, Colombo and Singapore in 10 day's frequency which is supplemented by a third vessel of 818 TEU from December 1988. Very recently this line was given loading rights for U.S.A. by C.F.B., as the first Japanese line to gain such rights. However throughput volumes are still small-say 150 TEUs per sailing.

Sea Consortium PTE Ltd.

This company (Seacon) is a Singapore based company. Among many other businesses relating to container operations, this company represents two Jersey based operators - West Asia Kontena Line (WAKL) and Bengal X-Press Container Line (BXCL) as a managing agent. BXCL further inaugurated Arabian X-Press Container Line (AXCL) from August 1988. WAKL, BXCL as well as AXCL operate common user feeder services for main line operators and do not compete with their clients in the fields of container traffic and marketing. Their clients include A.P.L., D.S.R., P.O.L., Y.M.L., L-T, P&O.CL, HOEGH, SEALAND, G.S.L., E.M.C., B.S.L., - almost all the ML container operators in this region. Among them, A.P.L. was the biggest client of Seacon.

However, this situation has entirely been changed from January 1st 1989 as reported earlier. Nevertheless, Seacon continues operating the following feeder network to/from Colombo.

A) Colombo/Bombay/Cochin/Colombo - One vessel every 14 days from Colombo. (AXCL Service)

B) Colombo/Bombay/Karachi/Dubai/Khor Fakkan/Bombay/Cochin/Colombo - Two vessels, 14 days frequency from Colombo (AXCL Service)

C) Colombo/Karachi/Colombo - One vessel every 12 days out of Colombo. A second vessels is expected to join the service by the end of March 1989. (AXCL Service)

D) Colombo/Madras/Colombo - One vessel. Weekly service (BXCL service)

E) Colombo/Chittagong/Mongla/Calcutta/Colombo - Two vessels. Frequency every 9 days (BXCL Service)

Common use feeder networks are indispensable to the transshipment base. When mainline operators choose a transshipment base port, they look at not only the port itself but also feeder links. With this in view, Seacon has contributed greatly to the development of the Port of Colombo.

4-3 Shipping Lines' Views on Colombo as a Transshipment Base

No Shipping operator has doubts about the geographical advantages of Colombo. Compared with the port of Singapore, both ports are ideally located for various routes but the area that would be covered via Colombo as a region could be greater than that of Singapore. Singapore appears superior to Colombo but due to the distance between both, both could be used as relay stations of different area coverages. The only conflict would be in the Upper Bay of Bengal area. Madras is unlikely to be considered as a threat to Colombo for the time being, due to its limited facilities. Colombo has already taken the lead in this region for the transshipment business and has thus induced the feeder operators. Mainline operators put priority on deviation, quick despatch, port and cargo handling cost etc. but at the same time availability and frequency of feeder networks cannot be overlooked. The ports in the Arabian Gulf, especially ports newly highlighted as transshipment bases located in the entrance of the Gulf such as Port Rashid, Khor Fakkan and Fujairah are getting in a competing position with Colombo. As a matter of fact, a certain portion of transshipment throughput held by Colombo is shifting to them. The common feeder operators are serving this area as well. However their area would be limited within the Gulf and at most up to Karachi, but the volumes cannot be under-estimated.

In the meantime there are ports on the Indian subcontinent that area planning to expand their facilities or are already under construction such as the new port of "NHAVA SHEVA" and the port of Madras. Cochin and Tuticorin will also be improved to a lesser extent. It is true that there are negative views on "NHAVA SHEVA" among the shipping circle in Colombo, partly due to the possible failure of efficient and systematic operations arising from too many different parties from different countries involved in this project or partly due to the limited number of facilities (three gantry cranes for three terminals with limited outreach). The fact that the Port Authority of Nhava Sheva did not publish tariffs yet is also a cause to stir up their apprehension, Indian ports do not apparently convince shipping lines of their reliability. In fact, the port of Bombay has been causing undue delays to Colombo callers.

Nevertheless a certain mainline operator will be encouraged by these new moves to increase periodic calls at these ports. but it would be rather minimal as mainline vessels of bigger size are unlikely to extend the number of transit times on the one hand and Colombo has now being accepted by shippers/consignees in India as the pivot port in the region. With this in view, it is unlikely that these ports will replace the position of the port of Colombo.

The above complimentary views on Colombo are, however, based on the assumption that the service standard rendered by Colombo should be upgraded or at least should not deteriorate. Certain shipping lines expressed apprehension pointing out that until completion of J.C.T - 3 sometime in 1992. S.L.P.A. would experience genuine difficulties to manage the increasing volumes brought by new port clients. It is pointed out earlier in this report that from the viewpoint of shipping operators, key factors which are taken into serious account are less deviation, quicker despatch and less operations costs. However, the most importance which should be evaluated prior to any of these factors is a stable port. The sudden necessity of eliminating the port call would jepordize the operation of entire container networks. In this respect the port of Colombo should overcome the bad image which it has regretfully given to its clients. A force, if S.L.P.A could establish one, is recommended to visit the principal offices of the major port clients.

Returning to the three factors mentioned above, less deviation from the great circle lines is a main sales point of the port of Colombo. As for cost factors, at the Gulf ports for an example, Khorfakkan provides services at cheaper cost than Colombo does, although its facilities are limited. In comparision with P.S.A's tariffs, those of Colombo are cheaper. S.L.P.A charges shipping lines handling fees of US$ 51.50/TEU for discharge from pre carriers and 28 days storage and reloading onto on/carries, while P.S.A charges S $ 100/TEU (approx., US$ 50.00 TEU) each for discharge and reloading. However, certain shipping agents mentioned that while the cost of container handling on paper is cheaper in the port of Colombo, there are many hidden costs when considering the productivity of operations as well as the number of staff the agents have to employ for port operations. Therefore, the net result would not show cheaper cost to the principals.

Other agents also pointed out hidden costs arising from inevitable hires of unreliable private flat-bed lorries for inter-terminal haulage of containers due to the lack of equipment on the part of S.L.P.A. Others also referred to the 28 days free storage time. Port Authorities in Singapore, Khor Fakkan and Madras do not charge penal rents retroactively from the first day when cargoes pass beyond the free time limit. Some others mentioned that in Singapore, incentives are given to shipping lines such as quantity rebates, and they positively evaluated the immediate connection of transshipment boxes at singapore.

Finally, there is the issue of quick despatch, guaranteed berth and productivity backed up by efficient yard operations. With regard to guaranteed berths, the scheduled time system now adopted by JAYE Container Terminals is similar to this. However, in view of unstabilized Indian ports, some J.C.T. callers have missed the scheduled time on many occasions. A feeder operator expressed strong dissatisfaction at S.L.P.A. pointing out that S.L.P.A. should introduce a more commercial concept. Their feeder vessels sometimes were pulled out to stream with small balance moves to accommodate other main line vessels. He claimed that without discharge of feeder cargoes, main line vessels would loose transshipment cargoes. He further asked why S.L.P.A. did not advise the agents of mainline operators for slow steaming to adjust the arrival time at Colombo, as high-speed mainline vessels could recover a delay of few hours easily on their ocean navigations. The improvement of the productivity of yard operations is also of the greatest importance and urgent necessity.

CHAPTER 5 TRAFFIC FORECAST

5-1 Population, Economy And Foreign Trade

In 1987, the population of Sri Lanka recorded 16.36 million. The average growth rate of the population from 1979 to 1987 is about 1.6% per annum (refer to Appendix 5-1).

According to the census in 1981, about 60% of the population comprises people of working age, from 15 to 60 years old.

The gross domestic product of Sri Lanka at 1975 constant prices in 1988 is Rs. 49,336.8 million.

According to the report of the Department of Census and Statistics, Ministry of Planning Implementation, the GDP of Sri Lanka from 1975 to 1988 gradually increased at an annual growth rate of about 4.7%.

Considering the various sectors of the economy, the mining and quarrying sector recorded the highest growth rate of about 12% per annum. This is followed by the transport and communications sector, the construction sector, and the manufacturing sector.

Agriculture, being the most fundamental and dominant sector in Sri Lanka, has a growth rate of only 2.8% per annum, which is the lowest among the major sectors.

The annual sectorial GDP from 1982 to 1988 at constant 1975 prices is shown in Table 5-1.

The future GDP at constant 1985 prices until 1991 was estimated in 1987 by the National Planning Division, Ministry of Finance and Planning, and the growth rates given in this table are used in this report (refer to Appendix 5-2).

Table 5-1 G.D.P. at Constant (1975) Prices

(Unit; Million R.P.)

	1975	1982	1983	1984	1985	1986	1987	1988
Agriculture, Livestock, Fisheries etc.	7,580.7	10,371.3	10,994.4	10,200.0	11,146.0	11,223.8	10,562.2	10,858.3
Mining and Quarrying	323.1	478.7	575.2	693.2	673.3	918.1	1,132.8	1,465.2
Manufacturing	6,651.7	7,281.8	7,063.5	8,299.7	8,811.9	9,344.8	9,670.0	9,928.6
Construction	1,262.4	2,157.3	2,171.6	2,199.9	2,248.2	2,419.2	2,556.5	2,587.5
Electricity, Gas & Water	116.9	221.8	226.4	252.5	273.9	293.8	304.1	313.9
Transport & Communication	2,361.8	3,657.8	4,042.6	4,530.6	4,607.4	4,718.1	4,803.2	4,817.4
Wholesale & Retail Trade, Restaurants & Hotels	4,882.8	9,408.4	10,161.7	10,907.1	11,421.7	11,983.1	12,422.0	12,711.5
Banking, Insurance & Real Estate, etc	336.0	714.0	756.8	832.4	896.5	932.3	989.2	1,033.7
Ownership of Dwellings	618.0	695.8	706.2	714.6	725.5	738.3	749.4	759.7
Government Services	1,324.9	2,255.6	2,272.0	2,297.6	2,334.0	2,379.7	2,474.8	2,487.1
Private Services	747.5	1,321.7	1,402.5	1,503.4	1,501.7	1,546.9	1,583.1	1,619.0
Import Duties	334.4	634.9	688.9	704.7	659.6	737.4	755.1	775.1
Gross Domestic Product	27,040.5	39,198.8	41,061.8	43,135.7	45,300.0	47,235.5	48,022.5	49,336.8

For GDP, the same average annual growth rates are assumed for the period from 1991 to 2001. Table 5-2 summarizes the calculated GDP values with the assumed growth rates for the planning period.

Table 5-2 GDP in 1990, 1996 and 2000 at 1975 Constant Prices

(Unit: Rs. Million)

Year	1990	1996	2001
GDP	56,329	73,355	91,414

Note: Growth rate is assumed as 4.5% per year for total G.D.P.

According to port statistics, the maritime dry cargo throughput of Sri Lanka in 1988 is about 10,466 thousand tons.
The values of import and export in 1988 are about Rs. 71,200 million and Rs. 46,928 million respectively (according to the Annual Report of the Central Bank of Sri Lanka).

The foreign trade of Sri Lanka is generally increasing in terms of both value and volume.

The value and volume of the marine external trade of Sri Lanka from 1981 to 1987 are shown in Appendix 5-3.

The major countries for the origin of imports are Japan, the United Kingdom, the U.S.A., Iran, India, China, Pakistan and France. The trade value from these countries to Sri Lanka accounts for 40% or more of the total import value of Sri Lanka.

The major countries for export are the U.S.A., G.F.R., the United Kingdom and Japan which account for 47% or more of the total export value of Sri Lanka (refer to Appendix 5-4).

5-2 Traffic Forecast

The major kinds of cargo throughput at Colombo Port are transshipment container cargo, local trade cargo including container cargo (foreign trade cargo) and coastal trade cargo (domestic trade cargo).

In this report, the volume of transshipment container cargo is estimated based on the volume of container cargo in the related neighbouring areas for transshipment containers.

The container cargo volume in the neighbouring areas is estimated using a macro-economic forecast.

The volume of the break bulk cargo of the local trade cargo is estimated by a macro-economic forecast and a micro-economic forecast. The volumes of the dry bulk cargo, the liquid bulk cargo and the coastal trade cargo are estimated by a micro-economic forecast.

5-2-1 Transshipment Container Cargo

(1) Methods of Forecast

The majority of transshipment container cargo at the Port of Colombo consists of the traffic between developed countries and Sri Lanka's neighbouring countries (feeder areas) such as Bangladesh, India, Pakistan and the Middle East. The feeder areas are separated into five categories, viz., Bangladesh, East India, West India, Pakistan and the Gulf and Red Sea.

The share of container transshipment throughput at Colombo Port in each area is calculated by taking the ratio of area estimates and that of SLPA's 1988 data.

The steps of the forecast for container cargo volume in each area are :

1) Estimate GDP for the planning period in each feeder area

2) Estimate the volume of containerizable cargo for the

planning period by its correlation to GDP

3) Estimate the trend of the ratio of containerization over the planning period by applying a logistic curve, and

4) Estimate container throughput for the planning period by multiplying 2) by 3).

In most cases, cargoes categorized as break-bulk are used for containerizable cargo, but in some cases, cargoes categorized as non-bulk cargo and even total cargo are also used due to the lack of adequate data.

The term "the ratio of containerization" means the ratio defined by (volume of container cargo)/(volume of containerizable cargo), and it is well known among advanced container ports that the chronological change of this ratio nicely fits a logistic curve, if the parameters are chosen properly.

The maximum limit of the ratio of containerization is assumed taking the experience of Japanese ports into consideration.

The net tonnage per TEU is estimated by taking the average of SLPA's data for 1985 and 1988 (for each feeder area).

The forecast flow of the transshipment container cargoes is shown in Appendix 5-5.

(2) Bangladesh

The major port of Bangladesh is Chittagong. Therefore, the majority of data for forecasting the container traffic in Bangladesh is chosen from the data of Chittagong port.

(a) Non-bulk cargo throughput

The volume of container cargo in Bangladesh is estimated from the non-bulk cargo throughput.

The GDP after 1985 is estimated based on the data taken from the report of the Bangladesh Energy Planning Project issued by the Planning Committee, Bangladesh.

The correlation equation between the volume of non-bulk cargo and GDP is;

$$Y = 1,116.511 + 3.572X \quad (r=0.819)$$

Here,

X : GDP of Bangladesh (thousand million TK)
Y : Cargo throughput of non-bulk cargo (thousand tons)
r : Correlation coefficient.

The GDP of Bangladesh is shown in Appendix 5-6.

(b) Container cargo throughput

The equation of the logistic curve estimated for forecasting the ratio of the containerization in Bangladesh is as follows:

$$Y = \frac{1}{0.011 + \left\{0.15 \times (0.674)^{t}\right\}}$$

Y = Containerized Ratio
t = Number of Years from 1980
(The graph is shown in Appendix 5-7)

The limit for the ratio of containerization is assumed as 90% of non-bulk cargo.

Sri Lanka's share of container transshipment to the total of Bangladesh, net tonnage per TEU and the ratio of empty containers are estimated as 23.9%, 10.4 tons per TEU, and 7.3% respectively.

The number of transshipment containers (TEU) between Sri Lanka and Bangladesh in 1990, 1996 and 2001 is shown in Table 5-3.

Table 5-3 Number of Transshipment Containers to/from Bangladesh

Year	1990	1996	2001
Container cargo volume in Bangladesh ('000 tons)	1,350	2,395	2,964
No. of total containers for transshipment ('000 TEU)	33	59	73

(3) India

The major ports in India are Bombay and Cochin on the west cost and Calcutta, Visakhapatnam and Madras on the east cost. Tuticorin is on the east coast but this port is regarded as one of the west coast ports in this study because of its geographical location relative to Colombo.

The data used for the forecast are mainly chosen from the port statistics of these ports.

(a) Break-bulk cargo throughput

The correlation equation between the volume of break-bulk cargo and GDP is;

$$Y = 7.573 + 0.009X \quad (r=0.865)$$

X : GDP of India (Rs. Hundred Million)

Y : Cargo throughout of break-bulk cargo (million tons), and

r : Correlation coefficient.

(The GDP of India is shown in Appendix 5-8)

(b) Container cargo throughput

The equation of the logistic curve is as follows:

$$Y = \frac{90}{1 + 10^{-(-1.226+0.098t)}}$$

Y : The ratio of containerization

t : Number of years from 1980

The limit for the ratio of containerization is assumed as 90% of the break-bulk cargo.
(The graph is shown in Appendix 5-9).

The ratio of the container cargo transshipped through Sri Lanka to the total container volume of India is 16.7% in West India and 24.6% in East India.

Net tonnage per TEU in West and East India and the ratio of empty containers to the total number of containers for transshipment in West and East India are estimated as 10.8 tons per TEU, 11.8 tons per TEU, 0.085 and 0.123 respectively.

The number of transshipment containers (TEU) between Sri Lanka and West and East India in 1990, 1996 and 2001 are shown in Tables 5-4 and 5-5, respectively.

The Port of Madras on the east coast of India presently accepts ore carriers of over 100,000 D/W and already has a container berth. At present, planning is under way for an additional container berth next to the existing berth which will be completed around 1993. These two berths will be used as one continuous terminal without draft limitation. Therefore, the transshipment cargo volume between Colombo and India will be reduced by about 500,000 TEU's by 2001 since some mother vessels will call at

Madras directly.

Table 5-6 summarizes the volume of transshipment containers between India and Colombo considering the effects of the above change.

Table 5-4 Number of Transshipment Containers to/from West India

Year	1990	1996	2001
Container cargo volume in West India ('000 tons)	7,011	15,391	22,784
Number of Transshipment Containers ('000 TEU)	118	201	232

Table 5-5 Number of Transshipment Containers to/from East India

Year	1990	1996	2001
Container cargo volume in East India ('000 tons)	3,004	6,596	9,764
Number of Transshipment Containers ('000 TEU)	70	117	129

Table 5-6 Number of Transshipment Containers to/from West India and East India (1990, 1996 and 2001)

(Unit: '000 TEU)

Year	West India	East India	Total
1990	118	70	188
1996	201	117	318
2001	232	129	361

(4) Pakistan

The major ports in Pakistan are Karachi and Qasim. The main data for the forecast are obtained from the statistics of these ports.

(a) Total cargo volume in Pakistan

The volume of containerizable cargo in Pakistan is estimated from the total cargo throughput at Karachi and Qasim.

The GDP of Pakistan after 1988 is obtained using a time series analysis.

$$Y = -30{,}324.636 + 15.437x, \quad (r=0.990)$$

Y : GDP (Rs. thousand million)
x : Year
r : Correlation coefficient

(The GDP is shown in Appendix 5-10).

The correlation equation between the volume of total cargo and the GDP is obtained using least square estimates.

$$Y = 2{,}576.135 + 53.476x, \quad (r=0.960)$$

Y : Total cargo volume (thousand tons)
x : GDP in Pakistan (Rs. thousand million)
r : Correlation coefficient

(b) Container cargo throughput

The logistic curve for the progress of the ratio of containerization to the total cargo volume is estimated as follows.

$$Y = \frac{60}{1 + 10^{-(-1.349+0.119t)}}$$

Y : The ratio of containerization

t : Number of years from 1980

(The graph is shown in Appendix 5-11).

The limit for the ratio of containerization is assumed as 60% of the total cargo.

The share of container cargo transshipped at Colombo to the total container cargo volume in Pakistan, net tonnage per TEU, and the ratio of empty containers are 6.2%, 12.1 tons per TEU and 0.235, respectively.

The number of transshipment containers (TEU) between Colombo and Pakistan in 1990, 1996 and 2001 are shown in Table 5-7.

Table 5-7 Number of Transshipment Containers to/from Pakistan

Year	1990	1996	2001
Container cargo volume in Pakistan ('000 tons)	6,778	14,182	18,652
Number of Transshipment Containers ('000 TEU)	43	90	119

(5) Gulf & Red Sea

The ratio of containerization of the Gulf & Red Sea area is assumed to have already reached its limit. Therefore, the number of containers at major ports in the Gulf & Red Sea area may be correlated directly to socio-economic indices such as GDP or population.

In this study, the number of containers (TEU) is estimated by correlating the number of containers to the population of the area under study.

Only Jordan, Saudi Arabia, U.A.E., Yemen Arab Republic, Ethiopia and Sudan have been taken into consideration in determining the population, since the recent data of the remaining countries was not available.

The population over the planning period is estimated using the correlation equation between year and population indices.

The correlation equation is as follows.

$$y = -4{,}496{,}577.3 + 2{,}310.1x, \quad (r=0.999)$$

y : Population ('000s), (Refer to Appendix 5-12)
x : Year
r : Correlation coefficient

The number of containers (TEU) at major ports in the Gulf & Red Sea area from 1980 to 1985 is shown in Appendix 5-13.

The correlation equation between population indices and the number of TEU's is estimated as follows.

$$y = -10{,}741.798 + 112{,}852x, \quad (r=0.960)$$

y : Number of TEU's ('000s)
x : Population indices
r : Correlation coefficient

The share of the number of transshipment containers between Sri Lanka and the Gulf & Red Sea area to the total container traffic of the area from 1990 to 2001 is estimated using the ratio obtained for 1988.

The number of transshipment containers at Colombo Port in 1990, 1996 and 2001 is shown in Table 5-8.

Table 5-8 Number of Transshipment Containers to/from Gulf and Red Sea

Year	1990	1996	2001
Number of Containers in Gulf & Red Sea ('000 TEU)	3,952	5,930	7,664
Number of Transshipment Containers ('000 TEU)	70	108	137

(6) Number of Transshipment Containers at Colombo Port in 1990, 1996 and 2001

The total transshipment containers (TEU) in 1990, 1996 and 2001 are shown in Table 5-9.

Table 5-9 Total Transshipment Containers (1990, 1996 and 2001)

(Unit: '000 TEU)

		1990	1996	2001
From/to the feeder ports	Bungladesh	33	59	73
	East India	70	117	129
	West India	118	201	232
	Pakistan	43	90	119
	Gulf & Red Sea	70	107	137
	Total	334	574	690
From/to the Mother Vessel's Ports		334	574	690
Total		668	1,148	1,380

5-2-2 Local Trade Cargo

(1) Macro-Economic Forecast

The macro-economic forecast is a method to estimate the total cargo volume as a whole based on the correlation between the cargo volume and major economic indices.

In this report, the break bulk cargo for local trade including container (Export and Import cargo) is forecast using the gross domestic product of Sri Lanka for the macro-economic forecast.

The correlation equations are as follows.

Import : $Y = -3,378.222 + 0.127x \quad (r = 0.9)$

where Y : Throughput of break bulk import cargo (1,000 tons)
x : GDP (Million Rp.)
r : Correlation coefficient

Export : $Y = 940.852 + 0.016x \quad (r = 0.7)$

where Y : Throughput of break bulk export cargo (1,000 tons)
x : GDP (Million Rp.)
r : Correlation coefficient

The statistics of the Sri Lanka Port Authority are used for cargo throughput. These data differ from the statistics of the Central Bank and the other government agencies. There is no available data for the total foreign trade volume in Sri Lanka.

The container cargo volume is estimated separately for import and export by multiplying the break bulk cargo volume by the ratio of containerization which is calculated based on the actual data of Colombo Port.

The maximum limit of the ratio of containerization is assumed taking the experience of Japanese ports into consideration.

The ratio of containerization during the planning period is calculated by the following equations.

$$\text{Import}: \quad Y = \frac{0.9}{1 + 10^{-(-0.768 + 0.039t)}}$$

$$\text{Export}: \quad Y = \frac{0.9}{1 + 10^{-(-0.607 + 0.077t)}}$$

where Y : Ratio of containerization

t : Number of years from 1980

(Refer to Appendix 5-14).

The limit for the ratio of containerization for both import and export is assumed as 90% of the break bulk cargo.

The net tonnage per TEU for laden containers is estimated as 13.7 tons per TEU for import and 12.5 tons per TEU for export, which are calculated based on the actual data of Colombo Port.

The number of empty containers is calculated by the difference between the number of import laden containers and the number of export laden containers, viz., the calculation of the empty containers is not necessary for the local trade figures.

The flow of the macro-economic forecast is shown in Appendix 5-15.

Table 5-10 Break Bulk Cargo

(Unit: '000 MT)

	Year	Import			Export			Total		
		Conventional	Container	Total	Conventional	Container	Total	Conventional	Container	Total
Actual	1981	1,475	199	1,674	1,178	330	1,509	2,654	529	3,183
	1982	1,212	277	1,488	1,167	399	1,566	2,378	676	3,054
	1983	1,531	339	1,870	1,167	383	1,540	2,687	722	3,409
	1984	1,798	378	2,161	1,232	470	1,702	3,022	841	3,863
	1985	2,120	438	2,568	1,212	506	1,717	3,340	944	4,284
	1986	2,167	526	2,693	992	648	1,639	3,159	1,174	4,332
	1987	1,924	578	2,502	817	659	1,475	2,741	1,237	3,977
Estimate	1990	2,788	1,015	3,803	863	983	1,846	3,651	1,998	5,649
	1996	3,743	2,284	6,027	580	1,546	2,126	4,323	3,830	8,153
	2001	4,367	4,032	8,399	438	1,987	2,425	4,805	6,019	10,824

Source of Actual Data: Port Statistics of SLPA

Table 5-11 Number of Containers for Local Trade

(Unit: '000 TEU)

	Year	Number of Containers			
		Laden Containers		Empty Containers	Total
		Import	Export		
Actual	1981	14	21	15	50
	1982	20	30	21	71
	1983	27	30	20	77
	1984	29	38	26	93
	1985	33	41	30	104
	1986	38	51	22	116
	1987	42	54	30	126
	1988	-	-	-	135
Estimate	1990	70	80	10	160
	1996	165	120	45	330
	2001	295	160	135	590

Source: Port Statistics of SLPA

The volume of break bulk cargo and container cargo in the future is shown in Table 5-10 along with the actual past data at Colombo Port.

(2) Micro-Economic Forecast

The micro-economic forecast is a method to estimate the cargo volume of each main commodity group individually. Then, the total sea trade cargo of Sri Lanka is calculated by the sum of these cargo volumes.

The main commodity groups for export and import are as follows.

For Import: Rice, Sugar, Fertilizer, Cement, Onions, Other break bulk cargo, Dry bulk cargo and Liquid bulk cargo.

For Export: Tea, Rubber, Coconuts & coconut products, Other break bulk cargo and Liquid bulk cargo.

(i) Import

(a) Rice

The import volume of rice is estimated by the difference between the consumption and the production. Existing stocks are ignored because according to Appendix 5-16, the sum of the production and imports from 1976 to 1987 is equal to the total supply in the same period.

The future consumption of rice is calculated by correlation with the projected population, using the average per capita consumption of rice from 1976 to 1987.

Appendix 5-16 shows the volume of the production, supply and imports from 1976 to 1981.

The Equation of supply of rice from 1990 to 2001 is as follows.

$$Y = 110 X$$

X: Population (Million)

Y: Supply of rice (000' MT)

The results of the calculation for 1990, 1996 and 2001 are shown in Table 5-12.

According to the Public Investment Report of the Ministry of Finance and the growth rate of the production until 1991 is assumed as 3% per year. The same growth rate is assumed for the planning period of this project.

The volume of rice imports during the planning period is shown in Table 5-12.

Almost all of the rice imports are handled at Colombo Port. The projected import volume of rice at Colombo port is shown in Table 5-12.

Table 5-12 Forecast Rice Imports

(Unit: '000 MT)

Year	Production	Consumption	Imports
1990	1,581	1,936	355
1996	1,888	2,167	279
2001	2,189	2,343	154

(b) Sugar

The consumption of sugar in Sri Lanka is estimated by correlation with the population until the upper limit of the per capita consumption, which is 30 Kg per annum.

After reaching this upper limit, the consumption of sugar increases at the same growth rate as the population until the end of the planning period.

The total supply and the sum of the production and the import volume are different in every year. But the sum of the supply from 1976 to 1987 is equal to the sum of the production and the import volume over the same period.

Therefore, the volume of imports is estimated by the difference between the consumption and the production.

Appendix 5-17 shows the consumption, production and per capita consumption of sugar in Sri Lanka.

The correlation equation between the consumption of sugar and the population is as follows.

$$y = -1,190.427 + 95.087x \quad (r \doteqdot 0.922)$$

y: Supply of sugar (000' MT)

x: Population (Million)

r: Correlation coefficient

According to the Public Investment Report of the Ministry of Finance, the volume of sugar production in Sri Lanka in 1987 and 1995 is 34.5 thousand tons and 150.0 thousand tons, respectively.

Therefore, the increase of sugar production is about 14.4 thousand tons per annum.

In this study, the annual increase of sugar production during the planning period is based on the above report.

The results of the calculation until the end of the planning period considering the upper limit of the per capita consumption are shown in Table 5-13.

Table 5-13 Sugar consumption, Import and Production

(Unit: '000 MT)

Year	Consumption	Import	Production
1990	483	405	78
1996	591	427	164
2001	639	424	215

Table 5-14 Import of Sugar

(Unit: '000 MT)

	1990	1996	2001
Colombo	397	418	416
Others	8	9	8
Total	405	427	424

(c) Fertilizer

The consumption of fertilizer in Sri Lanka is estimated by the sum of the consumption for the main agricultural commodities which are Rice (Paddy), Rubber, Tea, Coconuts and others.

1) Rice (Paddy)

The consumption of fertilizer for rice is estimated by the correlation between the production per hectare of paddy and the fertilizer use per hectare for paddy.

The upper limit of the production per hectare in 2001 is assumed as 3,400 Kg/hectare which is 70% of the production per hectare in Japan for paddy in 1984 considering the difference of production method and kind of seeds. Appendix 5-18 shows the production per hectare of paddy and the volume of fertilizer use per hectare from 1978 to 1987.

The correlation equation between the production per hectare of paddy and fertilizer use per hectare for paddy is as follows.

$$y = -72.2430 + 0.0926x \quad (r = 0.730)$$

y: Fertilizer use per hectare

x: Production per hectare of Paddy

r: Correlation coefficient

The production per hectare for the project planning period is expressed by the following equation.

$$y = 48.214x - 93{,}076.218$$

y: Production per hectare (Kg)
x: Year

The results of the calculation are shown in Table 5-15.

Table 5-15 Future Consumption of Fertilizer for Paddy

Year	1990	1996	2001
Production of Paddy ('000 MT)	2,324	2,775	3,217
Production of Paddy per Hectare (Kg)	2,870	3,159	3,400
Consumption of Fertilizer for Paddy ('000 MT)	157	194	230

2) Tea

The consumption of fertilizer for tea is estimated by the correlation between the production per hectare of tea and the fertilizer use per hectare.

The upper limit of the production per hectare in 2001 is assumed as 1,300 Kg/hectare which is 80% of the production per hectare in Japan for tea in 1985, considering the difference of production method and the kind of plants.

Appendix 5-19 shows the production per hectare of tea and the volume of fertilizer use per hectare from 1978 to 1987.

The correlation equation between the production per hectare of tea and fertilizer use per hectare for tea is as follows.

$$y = -330.6525 + 0.9821x \quad (r = 0.802)$$

y: Fertilizer use per hectare for tea (Kg)

x: Production per hectare of tea

r: Correlation coefficient

The production per hectare of tea for the planning period is expressed by the following equation.

$$y = 24.107x - 46,938.393$$

y: Production per hectare of tea for the planning period (Kg)

x: Year

The results of the calculation are shown in Table 5-16.

Table 5-16 Future Consumption of Fertilizer for Tea

Year	1990	1996	2001
Production of Tea ('000 MT)	225	257	288
Production of Tea per Hectare (Kg)	1,035	1,179	1,300
Consumption of Fertilizer per Hectare ('000 MT)	685	827	946
Consumption of Fertilizer for Tea ('000 MT)	149	180	210

3) Coconuts

The consumption of fertilizer for coconuts is estimated by the average consumption of fertilizer per metric ton of coconuts.

Appendix 5-20 shows the consumption of fertilizer for coconuts from 1979 to 1987.

The consumption of fertilizer for coconuts during the planning period of the project is shown in Table 5-17.

Table 5-17 Future Consumption of Fertilizer for Coconuts

Year	1990	1996	2001
Production of Coconuts ('000 MT)	3,525	3,958	4,319
Consumption of Fertilizer ('000 MT)	50	56	61

4) Rubber

The consumption of fertilizer for rubber is estimated by the average consumption of fertilizer per kilogram of rubber.

Appendix 5-21 shows the consumption of fertilizer for rubber from 1979 to 1987.

The consumption of fertilizer for the production of rubber for the project period is shown in Table 5-18.

Table 5-18 Future Consumption of Fertilizer for Rubber

Year	1990	1996	2001
Production of Rubber ('000 MT)	135	163	191
Consumption of Fertilizer ('000 MT)	26	31	36

5) Others

The consumption of fertilizer for crops other than rice, tea, coconuts and rubber is estimated by the average ratio of the consumption of fertilizer for others to the total consumption of fertilizer from

1982 to 1987.

The ratios from 1982 to 1987 are shown in Table 5-19.

Table 5-19 Ratio of Total Consumption of Fertilizer to Consumption of Others

Year	1982	1983	1984	1985	1986	1987
Production of Fertilizer ('000 MT)	225	141	153	29	15	21
Total Consumption of Fertilizer ('000 MT) (A)	379	405	471	493	497	507
Consumption of Fertilizer for Others (B) ('000 MT)	73	73	73	76	78	91
Percent of Others (B)/(A)	19.2	18.1	15.6	15.3	15.6	18.0

Source: Statistics of Central Bank

The study team has been informed that the domestic production of fertilizer will be abandoned due to the high production cost, and therefore the total volume of the forecast fertilizer demand shall be imported.

Presently almost all of the fertilizer imports are handled at Colombo port. The projected import volume of fertilizer at Colombo port is shown in Table 5-20.

Table 5-20 Fertilizer Imports for Planning Period

(Unit: MT)

Year	1990	1996	2001
Import Break Bulk	446,570	80,951	94,213
Import Bulk	-	458,722	533,872
Total	446,570	539,673	628,085

After 1995, about 85 percent of import fertilizer is assumed to be handled in bulk throughout the planning period.

(d) Cement

The import volume of cement is estimated by the difference between the consumption and the production.

The consumption and the production from 1982 to 1987 are shown in Appendix 5-22.

The consumption of cement after 1987 is calculated based on the per capita consumption of cement in Sri Lanka.

The per capita consumption of cement in 2001 is estimated by the correlation equation which is based on the per capita consumption of cement and the per capita GNP in 64 countries.

The correlation equation is as follows.

$$y = 0.03847x + 112.05$$

y: Per capita consumption of cement (Kg)

x: Per capita GNP at constant 1985 prices (US$)

The result of the calculation for 2001 is about 132 kg.

The per capita cement consumption from 1990 to 2000 is estimated by a linear equation between 59.9 kg and 132 kg per capita consumption in 1987.

The linear equation is as follows.

$$y = 5.15x - 10,173.15$$

y: Per capita consumption of cement (Kg)
x: Year

The results of the calculation in 1990, 1996 and 2001 are shown in Table 5-21.

Table 5-21 Per Capita Consumption of Cement

Year	1987	1990	1996	2001
Per Capita Consumption of Cement (kg)	59.9	75	106	132

The capacity of cement production in Sri Lanka is about 1,316 thousand tons per annum, but the average production is about 45% of the capacity or less because the supply of electric power is irregular and some facilities are too old to operate at full capacity.

The production is expected to increase beyond the present capacity to 1,994 thousand tons per annum supported by the modernization of existing facilities.

After these improvements, the average growth rate of cement production is forecast at about 5% per annum until 2001.

The future ratio of the volume of bagged cement to the total import volume is forecast at about 45%, which is based on the present ratio at Colombo Port.

The future volume of cement imports is forecast as shown in Table 5-22.

Table 5-22 Future Import of Cement

Year	1990	1996	2001
Consumption ('000 MT)	1,326	2,093	2,802
Production ('000 MT)	930	1,524	1,944
Import Break Bulk ('000 MT)	178	256	386
Import Bulk ('000 MT)	218	313	472

(e) Onions

The import volume of onions is estimated by the difference between the consumption and the production. The consumption of onions in Sri Lanka is estimated by the per capita consumption of onions which is set at 6.2 Kg per person based on the average per capita consumption of onions from 1983 to 1987 in Sri Lanka (Appendix 5-23).

The production of onions in Sri Lanka during the planning period of this project is about 61,000 tons per annum which is decided based on the average production of onions from 1976 to 1986 in Sri Lanka (Appendix 5-24).

The projected import volume of onions during the planning period is shown in Table 5-23.

Almost all of the onion imports are handled at Colombo Port. The projected import volume of onions at Colombo Port is thus the same as the national figures shown in Table 5-23.

Table 5-23 Import of Onions

Year	1990	1996	2001
Import of Onions ('000 MT)	48	61	71

(f) Other Break Bulk Cargo

Import other break bulk cargo is comprised of all break bulk cargo other than rice, sugar, bagged fertilizer, cement in bags and onions.

The import volume of other break bulk cargo is estimated by the correlation with the GDP.

The volume of other break bulk cargo from 1982 to 1987 is shown in Appendix 5-25.

The correlation equation between the volume of other break bulk cargo and the GDP is as follows.

$$y = 0.0495x - 1{,}006.617 \qquad (r = 0.928)$$

y: Volume of other break bulk cargo
x: GDP
r: Correlation coefficient

The results of the calculation for 1990, 1996 and 2001 are shown in Table 5-24.

Table 5-24 Imports of Other Break Bulk

(Unit: '000 MT)

Year	1990	1996	2001
Port of Colombo	1,621	2,388	3,202
Total Import Volume in Sri Lanka	1,782	2,624	3,518

(g) Dry Bulk

Until now, the dry bulk cargo in Sri Lanka consists of bulk cement and other dry bulk cargoes, but imported fertilizer will be added to dry bulk cargo as one of the main bulk commodities, under the government policy shifting from importing fertilizer in bags to importing in bulk.

Detailed data on the other dry bulk cargo, such as the volumes of individual commodities, are not available. Therefore, the forecast of the other dry bulk cargo is executed utilizing the ratio of the other dry bulk cargo volume to the total break bulk cargo volume.

The ratio is five percent, which is calculated based on the statistics of SLPA in 1986 and 1987.

The volumes of other dry bulk cargo and bulk cement in 1986 and 1987 are shown in Appendix 5-26.

The volume of the import bulk cement and the import fertilizer in 1990, 1996 and 2001 are shown Table 5-22 and Table 5-20.

The results of the forecast are shown in Table 5-25.

Table 5-25 Import of Dry Bulk (1990, 1996, 2001)

(Unit: '000 MT)

Year	1990	1996	2001
Cement	218	313	472
Fertilizer	0	458	534
Others	152	174	216
Total	370	945	1,222

(h) Liquid Bulk

The major commodities of liquid bulk cargo are crude oil and oil products.

The oil products mainly consist of auto diesel, super petrol, kerosene and avgas.

The volumes of imported crude oil and oil products are estimated using a time trend analysis and the growth rate of GDP.

From 1990 to 1994, the volume is calculated by time trend analysis based on the data from 1984 to 1987 because of the insecure political conditions and the aftereffects of these conditions from 1988. So, the growth of energy consumption for oil is estimated assuming a relatively stable political situation as in 1984 to 1987.

From 1995 until 2001, the volume is calculated using the growth rate of GDP which is about 5.0 percent per annum.

The estimation equations are as follows.

From 1990 to 1994:

$$Yn = 17.3x - 32{,}456.4$$

From 1995 to 2001

$$Yn = 1.05\ Yn\text{-}1$$

here Yn: Import volume of crude oil and oil products in the target year.

x : Year

Yn-1: Import volume of crude oil and oil products in the previous year.

Appendix 5-27 shows the imports of oil and oil products from 1979 to 1987.

The results of the forecast are shown in Table 5-26.

Table 5-26 Future Import of Oil (1990, 1996 and 2001)

(Unit: '000 MT)

Year	1990	1996	2001
Crude Oil	1,759	2,007	2,562
Oil Products	212	242	308
Total Import	1,971	2,249	2,870

(ii) Exports

(a) Tea

The growth rate of the export volume of tea in the planning period of this project is estimated based on the average growth rate of the export volume of tea in the world.

The growth rate of the export volume of tea in Sri Lanka is less than the world average.

The average growth rate of the export volume of tea in the world from 1975 to 1985 and in Sri Lanka from 1979 to 1987 are 2.3 percent per annum and 0.8 percent per annum respectively.

But the government of Sri Lanka is strongly promoting tea production and export. For example, the average tea production per hectare in Sri Lanka from 1984 to 1987 is about 1.2 times the average from 1980 to 1983.

Therefore, in this study, the average growth rate of the export volume of tea is assumed as 2.3 percent per annum after 1990.

The growth rate of the local consumption of tea is about 1.88 percent per annum, which is equal to the growth rate of the population in Sri Lanka.

Table 5-27 shows the forecast tea production and exports of Sri Lanka during the planning period of this project.

Table 5-27 Export of Tea

(Unit: '000 MT)

Year	1990	1996	2001
Export	212	243	272
Local Consumption	13	14	16
Production	225	252	288

(b) Rubber

Rubber is one of the main export commodities in Sri Lanka. The government of Sri Lanka has a strong promotion plan for rubber exports.

From "Public Investment," which is a report of the Ministry of Finance and Planning in 1987, the growth rate of export rubber in Sri Lanka is about 3.4 percent per annum until 1991.

Therefore, in this report, the growth rate of rubber exports in the planning period of this project is set at 3.4 percent based on the "Public Investment" report.

The growth rate of the local consumption is assumed at 1.88 percent per annum, which is equal to the growth rate of the population in Sri Lanka.
The forecast volume of exports and the forecast

production of rubber in Sri Lanka are shown in Table 5-28.

Table 5-28 Export of Rubber

(Unit: '000 MT)

Year	1990	1996	2001
Export	117	143	169
Local Consumption	18	20	22
Production	135	163	191

(c) Coconuts & Coconut Products

Coconuts and coconut products are one of the main export commodities in Sri Lanka.

The growth rate of these exports is very low at present around the world.

But in Sri Lanka, the trend of these exports is slowly growing because the government of Sri Lanka is strongly promoting the export of these commodities.

The export volume of these commodities is estimated assuming a continuation of the present trend.

The export volume is estimated by time trend analysis using the following equation.

$$y = 12.65x - 24,917.425$$

y: Volume of export coconuts & coconut products (including bulk coconut oil)

x: Year

Table 5-29 shows the forecast export volume of coconuts & coconut products.

Table 5-29 Export of Coconuts & Coconut Products

(Unit: '000 MT)

Year	1990	1996	2001
Export	256	332	395

(d) Other Break Bulk

Other export break bulk cargo is comprised of all break bulk cargo other than tea, rubber and coconuts & coconut products.

The export volume of other export break bulk cargo is estimated by time series analysis.

The volume of other export break bulk cargo from 1982 to 1987 is shown in Appendix 5-28.

The estimation equation is as follows.

$$Y = 13.87x - 27{,}187.03$$

x : Year

Y : Export volume of other break bulk cargo

The results of the calculation for the planning period of this project are shown in Table 5-30.

Table 5-30 Export of Other Break Bulk
(1990, 1996 and 2001)

(Unit: '000 MT)

Year	1990	1996	2001
Export	414	497	567

(e) Liquid bulk

There are two main kinds of export liquid cargo in Colombo Port: 1) oil products which consist of fuel and naphtha, and 2) coconut oil.

The export volume of fuel has decreased slightly since 1980.

The export volume of naphtha has increased slightly, but recently, the export volume has remained constant. There is a trend for oil products to be refined by oil-producting countries.

Thus, the export volume of oil products is not likely to increase during the planning period of this project.

So, the future export volume of oil products is estimated by the average export volume of oil products from 1983 to 1987.

The future volume of coconut oil exports is estimated by the ratio of export coconut oil to export coconuts and coconut products. This ratio is about 15 percent (Appendix 5-29).

Table 5-31 shows the forecast export volume of oil products and coconut oil.

Table 5-31 Export Liquid Bulk

(Unit: '000 MT)

Year	1990	1996	2001
Oil Products	213	213	213
Coconut Oil	38	50	59
Total	251	263	272

(iii) Container Cargo for Export/Import Trade

(a) Method of Forecast

The number of containers and the volume of container cargo for export/import trade in Sri Lanka are forecast by the following procedure.

1 Selection of containerizable cargo

2 Estimation of the ratio of container cargo to containerizable cargo.

3 Estimation of the number of containers and the volume of container cargo.

(b) Containerizable Cargo

The main commodities of containerizable cargo for import are sugar, bagged fertilizer, onions and other break bulk cargoes; and for export the cargoes are tea, rubber, coconuts and coconut products and other break bulk cargoes.

The volume of containerizable cargo is calculated as the sum of the above commodities in the break bulk cargo, which is estimated in (i) and (ii) above.

(c) Ratio of Containerization

The ratio of container cargo volume to containerizable cargo volume is estimated using a logistic curve based on the statistics of Sri Lanka Port Authority.

The equations of the logistic curves are as follows.

Import:

$$Y = \frac{0.99}{1 + 10^{-(-0.794 + 0.047x)}}$$

Export:

$$Y = \frac{0.99}{1 + 10^{-(-0.405 + 0.085x)}}$$

x: Number of years from 1980

Y: Ratio of containerization

Table 5-32 shows the ratio of containerization to containerizable cargo.

Table 5-32 Ratio of Containerization

	Year	Ratio of Containerization (Export)	Ratio of Containerization (Import)
Actual	1982	0.370	0.190
	1983	0.380	0.200
	1984	0.460	0.190
	1985	0.490	0.200
	1986	0.540	0.230
	1987	0.630	0.260
Estimate	1990	0.728	0.321
	1996	0.891	0.475
	2001	0.950	0.608

Source of actual data: Port statistics, Sri Lanka

(d) Calculation of Container Cargo Volume and Number of Containers

1) Calculation of Container Cargo Volume

The local container cargo volume is calculated by multiplying the ratio of containerization which is estimated in (c) by the volume of the containerizable which is calculated in (b).

2) Calculation of the Number of Containers (TEU) for local trade

The container cargo volume per TEU for local trade is estimated using the data in (i) and (ii) and SLPA statistics.

Then, the number of containers for the planning period of this project is estimated by dividing the container cargo volume which is estimated in 1) by the container cargo volume per TEU.

Table 5-33 shows the container cargo volume and the number of containers for local trade during the planning period of this project.

Table 5-33 Container Cargo Volume and Number of Containers

Year	Container Cargo Volume		Number of Containers
	Export ('000 MT)	Import ('000 MT)	('000 TEU)
1990	689	806	150
1996	1,025	1,400	216
2001	1,264	2,299	354

(iv) Coastal Trade

Almost all of the coastal trade at Colombo Port is inward cargo from Trincomalee.

The reason for the rapid growth of coastal trade at Colombo Port in recent years is the insecure road traffic situation between Colombo and Trincomalee because of the unstable political situation.

Therefore, the volume of coastal trade is not likely to increase after the political conditions improve.

So, the volume of coastal trade at Colombo Port during the planning period is calculated based on the average in 1986 and 1987.

The past record and the result of the calculation for coastal trade at Colombo Port are shown in Table 5-34.

Table 5-34 Coastal Trade at Colombo Port

	Year	Inward ('000 MT)	Outward ('000 MT)	Total ('000 MT)
Actual	1981	73.7		73.7
	1982	2.5		2.5
	1983	49.8		49.8
	1984	72.4		72.4
	1985	93.9		93.9
	1986	178.5	60.0	238.5
	1987	194.5	15.8	210.3
Estimate	1990	186.5	37.9	224.4
	1996	186.5	37.9	224.4
	2001	186.5	37.9	224.4

Source of actual data: Port statistics, Sri Lanka

(v) Cargo Throughput at Colombo Port during the Planning Period

The result of the micro-economic forecast for cargo volume at Colombo Port is shown in Table 5-35.

Table 5-35 Cargo Throughput at Colombo Port

(Unit: '000 MT)

Year	Foreign Trade							Total Foreign Trade			Total coastal Trade
	Break Bulk Cargo				Dry Bulk Cargo	Liquid Bulk Cargo					
	Conventional		Container								
	Import	Export	Import	Export		Import	Export	Break Bulk	Dry Bulk	Liquid Bulk	
1990	2,241	257	806	689	370	1,971	251	3,993	370	2,222	224
1996	2,084	126	1,400	1,025	945	2,249	263	4,635	945	2,512	224
2001	2,023	66	2,299	1,264	1,222	2,870	272	5,652	1,222	3,142	224

(3) Local Cargo Volume

According to Tables 5-10 and 5-35, there is a large difference between the results of the macro-economic forecast and the micro-economic forecast.

The reason for the above difference is the different sources of data, viz., the majority of the data of the macro-economic forecast is from the statistics of SLPA and the majority of the data for the micro-economic forecast is from the central bank and customs.

The results of the macro-economic forecast and the micro-economic forecast are adopted as a high estimation and a low estimation.

After discussions with SLPA, the data of the central bank and the customs is to be given priority for the port planning. Therefore, the micro-economic forecast is used as the basis for the port development plans.

5-2-3 Cargo Throughput at Colombo Port

From 5-2-1 and 5-2-3, the forecast cargo throughput at Colombo Port during the planning period is shown in Table 5-36.

Table 5-36 Total Cargo Throughput at Colombo Port in 1990, 1996 and 2001

Year			1990	1996	2001
Export and Import cargo	Conventional Cargo ('000 MT)		2,498	2,210	2,089
	Container Cargo ('000 TEU)		150	216	354
	Dry Bulk Cargo ('000 MT)		370	945	1,222
	Liquid Bulk Cargo ('000 MT)		2,222	2,512	3,142
	Total	Conventional ('000 MT)	5,098	5,667	6,453
		Container ('000 TEU)	150	216	354
Total Transshipment Cargo ('000 TEU)			668	1,148	1,380
Total Coastal Cargo ('000 MT)			224	224	224
Total Cargo Throughput	Conventional Cargo ('000 MT)		5,314	5,891	6,677
	Container Cargo ('000 TEU)		818	1,364	1,734

However, it is assumed that the break bulk cargo throughput, including containers, in 1990 will be delayed by about one year because of the insecure political conditions in recent years in Sri Lanka.

Considering the above conditions, the cargo throughput at Colombo Port in 1990 is shown Table 5-37.

Table 5-37 Adjusted Cargo Throughput at Colombo Port in 1990

Year			1990
Export and Import cargo	Conventional Cargo ('000 MT)		2,555
	Container Cargo ('000 TEU)		137
	Dry Bulk Cargo ('000 MT)		370
	Liquid Bulk Cargo ('000 MT)		2,222
	Total	Conventional ('000 MT)	5,147
		Container ('000 TEU)	137
Total Transshipment Cargo ('000 TEU)			572
Total Coastal Cargo ('000 MT)			224
Total Cargo Throughput	Conventional Cargo ('000 MT)		5,371
	Container Cargo ('000 TEU)		709

CHAPTER 6 MASTER PLAN

6-1 General Approach

(1) Development Potential of Existing Port Layout

The most important assets of the Port of Colombo todays are i) its large basin which has been designed and used for extensive bunkering and lighterage operations, and ii) a virtually continous waterfront line which is not intensively used for cargo operations. The first step of redevelopment has been taken by utilizing these assets.

The construction of JCT No. 1 and No. 2 Berth was realized by demolishing unused bunkering jetties and reclaiming the water area in front. The areas which can be redeveloped from now on are i) from Baghdad Warehouse to Barge Repair Basin and ii) the north side of North Pier. Thanks to the spacious basin, main entrance, and channel alignment, the breakwater system would not require major modifications.

The redevelopment of the port, therefore, can be worked out with a reasonable amount of investment. This is an extremely important prerequisite for the successful planning of the Port of Colombo because most of the expected increase in port traffic will be induced by the rapid growth of international transshipment container cargo.

The present situation of international container transshipment in the region is discussed in Part 3 of this report, and there is severe competition among ports. In order to maintain its reputation as the number one container transshipment port of the region, the Port of Colombo must continue to provide reasonable port charges and tariffs and make full use of its geographical advantages. In this relation, it is worthwhile to note that the success of Singapore, Hongkong, and Kaoshiung as major container transshipment ports is not only because of their locational advantages but also due to their less costly development schemes.

(2) Complementary Function - Port of Galle

The development of Galle port is one of Sri Lanka's highest priority projects under the present government policy. The port, similar to Colombo is located on the main shipping routes and has the potential to develop into a container transshipment port complementing Colombo. Though the port of Galle presently handles a certain amount of cargo, a substantial amount of investment for breakwaters, channels and basins, which will not yield direct financial benefits, is a pre-requisite for large-scale development.

In view of rather limited financial resources available, for the time being, within SLPA, the development of Galle heavily depends upon possible financing schemes. Therefore establishing an exact schedule for its development is extremely difficult at this stage. In order to cope with this situation and establish a balanced development program for Sri Lanka's port system, the master plan for Colombo port is flexible enough for adjustment in response to the different scenarious of development at Galle port.

(3) Basic Functions as a Major Port

The required functions of gateway ports to the country encompass a wide range of activities. Firstly, as the main commercial port for the country, Colombo shall accommodate various types of vessels which will call at the various port within the planning horizon safely, and handle types of cargoes efficiently. The design of a physical plan to fulfill these requirements with the minimum cost is the core of the planning work, and most of this report is dedicated to this subject.
Secondly, the port should lead the development of the country as an information center for commerce and industry. In this regard, Colombo, a long - standing transshipment port, has been accumulating these functions and related supporting software such as shipping agents, cargo forwarders, banking and insurance

systems, ship repairing, logistics and so on. In formulating master plan, due consideration is given to strengthening these functions.

Thirdly, the gateway port should maintain and improve its role as the face of the country, which in many cases is integrated with the mother city. Colombo port, in this respect, still has many areas to be improved. In this report some of the major items, such as port highway, relocation of old and obsolete facilities, and extension of Galle face road into the port area are proposed. In order to provide the necessary preparation for land and water areas acquisition, which is the key for the creation of an excellent port/city environment, a long-term conceptual plan is prepared and attached.

(4) Management and Operational Aspects

The improvement of managerial and operational skills are indispensable to make full use of the constructed facilities. For Colombo port, the importance of these aspects is further intensified because the ports is further intensified because the ports main activity, international container operation, is a foot-loose and extremely cost conscious business. The proposed master plan, therefore, has been prepared on the assumption that Colombo port will achieve a high level of efficiency, eg. 300,000 TEU per fully-equipped container terminal. This requirement becomes very severe since the targeted efficiency should be achieved before the completion of JCT No. 3 terminal to cope with the anticipated demand.

6-2 Cargo Throughout and Required Facilities

6-2-1 Berths

(1) Existing berths and their capacities

The existing berths of Colombo Port and their present capacities are evaluated in the following table.

As the capacities of the existing container berths can be increased, evaluations of berth capacities after improvement are also indicated in the table.

Table 6-2-1 (1) Berth Capacity

Container Wharf	Capacity (TEU)		Note
	Present	Improved (1995)	
QCT #4 #5 #6	200,000	340,000	+ One Gantry Crane (Total 3 nos) + 23,000 m^2 + to connect JCT computer
JCT #1 #2	400,000	600,000	+ 2 Transfer Cranes (Total 12 nos)
Container total	600,000	940,000	TEU

Table 6-2-1 (2) Berth Capacity

	Break bulk	Dry bulk	Liquid bulk	Remarks
QEQ # 1	250,000			to be shifted to other berths.
QEQ # 2	250,000			
QEQ # 3	250,000			
BQ # 1	250,000			
BQ # 2	250,000			
BQ # 2'	150,000			
BQ # 3	250,000			
BQ # 4	250,000			
CB # 1	100,000			
CB # 2	100,000			
GP # 2	150,000			
PVQ # 1	250,000			
PVQ # 2	130,000	300,000		cement, wheat
NORTH PIER			2,000,000	to be shifted to dolphin berth.
SOUTH JTTY			300,000	
SOUTH PIER			100,000	
SPMB			2,000,000	capa=3,000 t/h
TOTAL	2,630,000	300,000	4,400,000	

It will be difficult to significantly increase the capacity of the General Cargo berths.

(2) Required berths

The forecast cargo demands at the target years 1995 and 2001 are summarized in Table 6-2-2.

Table 6-2-2 Forecast Cargo Demand

Type of Cargo	in 1995	in 2001	Remarks
Container	1,360,000 TEUs	1,730,000 TEUs	
Break Bulk	2,070,000 TEUs	2,020,000 Tons	Majority of fertilizer will be handled in bulk
Dry Bulk	960,000 Tons	1,240,000 Tons	
Liquid Bulk	2,400,000 Tons	3,150,000 Tons	

Berth requirements for each type of cargo are examined in the fallowing four sections to cope with the estimated demand.

1) Container berths

Our first target year is 1995, and the forecast container throughput is 1.36 million TEUs. As discussed in the previous section, the existing container handling capacity is estimated at 0.94 million TEUs after the completion of various improvement schemes. The standard capacity of fully equipped container terminals is estimated at 300,000 TEUs per berth. It is also almost certain that Galle port will not provide substantial container handling capacity before 1996 even under the most optimistic scenario.

Therefore, the forecast container throughput, 1.36 million TEUs, will be covered by the construction of two new container berths, namely JCT No. 3 and No.4.

$$1,360,000\ (\text{TEUs}) = 300,000\ (\text{TEUs/berth}) \times N(\text{berth}) + 940,000\ \text{TEUs}$$

N: number of berths to be constructed by 1995

According to the proposed construction schedule, JCT No. 3 and No. 4 berth will be constructed and put into operation in 1993 and 1994 respectively. The planned container handling capacity of Colombo port in 1994 will be 1.54 million TEUs, and demand will catch up with this capacity around 1997.

In case the development of Galle port can not provide any container capacity by 1997, further development of container handling capacity at Colombo port becomes necessary to meet the forecast container handling requirements of Sri Lanka. Under this scenario, two master plans, Master Plan A and Master Plan B, are prepared for Colombo port. In either case, the required increase in container handling capacity shall be met by the expansion/improvement of QCT, and the planned total capacity at the target year of master plan (2001) will be 2.1 million TEUs for both plans.

The merits and demerits of the two plans are discussed in Section 6-3-1. However the difference in the required construction period associated with the two plans should be mentioned here. To make the first set of facilities operational in 1977, the first step for construction work shall be started in 1993 under master plan A, and in 1994 under master plan B.

In case the its first fully equipped container berth at Galle is completed in 1997 and the second in 1999, the container handling capacity at Galle will be 300,000 TEUs in 1997 and 600,000 TEUs in 1999. Under this scenario, the target year of the master plan (2001) shall be shifted further. In any case, a final decision for the course of development, either at Galle or Colombo, shall be taken in 1993 (in case of master plan A) or 1994 (in case of master plan B).

2) Break bulk berths

Presently, the port handles some 2.4 million tons of break bulk cargo and has the capacity to handle 2.63 million tons of break bulk cargo annually. However, the demand is estimated as 2,000,000 tons in 1995 because fertilizer will be handled in bulk at the new North Pier area which is presently used for oil.

After 1995, with the improvement project of QCT, the capacity to handle break bulk cargo will decrease by 750,000 tons from the reconstruction of QEQ (#1, #2, and #3) and by 650,000 tons at BQ (#1, #2, #2') from the reclamation of the Fort area (corresponds to Plan-A).

Considering this situation it is natural to reconstruct the North Pier in an early stage of the short term development plan.

Since the dry break bulk cargo demand will level off after 1995, no additional break bulk berths will be necessary except under Plan-A which involves the reclamation of the Fort area.

3) Dry bulk cargo berths

At present the port has dry bulk handling facilities for cement and wheat at the foot of the PVQ, but this is not a specialized berth for bulk handling; the P.V.Q handles break bulk cargo, too.

If the cement handling increase rapidly, a temporary mooring space for cement vessels should be considered in front of the new North Pier #4 area to ease the congestion and save money caused by the loss of time at the PVQ.

Considering the efficiency and the cost savings for transportation including export countries' it is also advisable to handle fertilizer in bulk.

For this purpose, a new berth at the north pier, equipped with unloading machinery, sheds for storage, and mixing and bagging machinery, shall be included in the short term plan.

4) Liquid bulk berths

The Ceylon Petroleum Corporation constructed a Shingle Point Mooring Buoy (SPMB) outside the port in 1986.

The facility has a 1,062 m/m diameter, 9,000 meter long pipeline with a 24" submarine hose.

This facility has an oil handling capacity of 3,000 ton/hr. This will be able to handle some 2,000,000 tons of oil per year despite the unfavourable location.

Together with this facility, the utilization of the dolphin berth inside the Island Breakwater will provide sufficient capacity to meet the requirements in both 1995 and 2001.

In order to shift the oil handling operation to the new dolphin berths, the pipe laying work shall be commenced at the earliest possible date.

To this aim, we surveyed the soil stratum between the dolphin and the North Pier.

The results of the survey show that there are possible routes which minimize the rock excavation. There is also a possibility to reduce the pipe laying cost by utilizing the new NP wharf for the preparatory works for the pipe laying.

Thus it is advisable to implement the pipeline works at the earliest possible date and to revise the work plan to minimize the cost.

As for the coconuts oil handling facilities, the port presently has storage tanks (16,000 tons) and pipe lines (8") with the handling speed 250 ton/hr.

Coconuts oil is handled at south pier through the pipelines. Previously, handled volume reached 100,000 tons/year, but presently it is not handled so much.

According to our estimation the volume of coconuts oil to be handled in 2001 is 60,000 tons/year.

The port is capable to handle the forecast volume without any additional capacity.

6-2-2 CFS and Warehouses

(1) CFS (for export and import cargo)

The demand for the CFS for export and import (domestic) cargoes can be estimated according to past data:

There are 27,200 m^2 of CFS (13,300 outside the port, 8,500 at QCT, and 5,400 at JCT) excluding factory facilities.

The total number of domestic containers handled was about 120,000 TEUs. Thus we obtain the unit value of 225 m^2/1,000 TEUs.

Assuming the unit space required for container handling in CFS will remain unchanged, we estimate the necessary area of the CFS in Table 6-2-3.

Table 6-2-3 CFS Demand

Year	Domestic containers (TEUS)	Necessary area for CFS (m^2)	Shortage (m^2)
1995	214,000	48,150	(until 1995) 21,000
2001	352,000	79,200	31,000 (after 1995)

Comparing these figres with the standard values of 39 tons/m^2/year, we understand that this result is reasonable.

(2) CFS (for transshipment cargo)

As there are no data available for the stuffing and unstuffing of transshipment cargo, the study team assumes that the demand is small.

Presently, the port handles some 400,000 TEUs of transshipment containers. The study team estimates that of some 6,000 TEUs (1.5% of the total) would require stuffing/unstuffing at the CFS.

In the year 2001, the total number of transshipment containers is estimated as 1,380,000 TEUs. Considering the above, there may be a demand for some 20,000 TEUs of stuffing unstuffing. Thus we can assume the Kochchicade area with 9,000 m^2 of warehouses can meet the demand with the necessary modifications.

(3) Warehouses

The demand for warehouses seems stable even in the year 2001.

Considering the present condition of the port, new warehouses shall only be constructed at the NP wharf. The necessary area will be 6,000 m^2/berth which is almost the same area per berth as at the warehouses at Bandaranaike Quay.

(4) Open storages

At present, there is a shortage of open spaces for smooth transport of cargo within the port area.

Open storages shall be paved whenever possible to ensure smooth transportation.

6-2-3 Cargo Handling Machinery

(1) Container handling

At this moment, standard sets of machinery are considered for convenience.

But other variations can be considered when appropriate.
The container handling equipment is listed as a standard set in Table 6-2-4.

Table 6-2-4 Container Handling Equipment
(per berth)

Gantry crane	2 nos
Transfer crane	6 nos
Tractor trailer	12 sets

(2) Break bulk cargo handling

As it is difficult to estimate the exact figures, an example is shown below.

Forklift 10 sets/berth

(3) Dry bulk and liquid bulk

The port has the following machinery to handle bulk cargo.

Cement handling ...
four pipelines (max. handling speed=200 tons/h)
and silos (stock capa.= 14,000 tons) at PVQ

Wheat handling ...

one rail mounted unloader with two pneumatic booms at PVQ connected by a belt conveyer to silos.

Oil handling (1)

loading and unloading arms, & pipelines (the biggest is 24" = 1,000 tons/h)

at North Pier & South Jetty, Booster pump at Weragooda.

Oil handling (2)

a 1,062 mm dia pipeline with a 24" submarine hose at SPMB (which enables crude oil handling at the rate of 3,000 tons/h with a ship booster)

Coconuts Oil handling

pipelines with tanks at south Jetty area. which have a handling capacity of 100,000 tons/year

The oil handling facilities at north pier and south jetty will be shifted to the dolphin berth with in the Short Term plan.

In addition to the above, the port will have to be equipped with handling machines for bulk fertilizer at the new north pier area within the short term development scheme. The composition of handling machines for bulk fertilizer will include two unloaders (handling rate 200 tons/h per unloader), belt wheat handling and Coconuts Oil handling will not require further capacity through 2001.

(4) Computer and Communication System

An information system shall be developed to facilitate the handling of a large volume of containers, and at the same time, the port shall furnish information to all port customers in a timiely manner.

As the port has already started to computerize, it will be easy to extend the system or widen the coverage to various fields.

6-3 Master Plan (Target Year 2001)

6-3-1 Layouts

Two alternative layouts for the Master Plan, namely, Plan-A and Plan-B, are shown Fig. 6-3-1 (1) to Fig. 6-3-1 (2).

The major characteristics of the plans are:

Plan-A emphasizes the maximum utilization of the existing potential of the port. Thus the reclamation is planned within the port basin by shifting the break bulk operation from BQ/QEQ to NNP.

Plan-B retains the open space inside the port and new land is obtained by reclaiming the outside of QEQ. In short, Plan-B is more expensive than Plan-A, but Plan-B provides a direct and simple solution for the space shortage.

A comparison between the two alternatives is shown in Table 6-3-1.

Table 6-3-1 Comparison of the two alternatives

	Plan-A	Plan-B
Extension of Breakwater	Length shorter. Able to finish in a short period. Wave dissipating type is preferable.	Length longer. Better to construct after reclamation. No wave reflection towards wharves.
Effect of the Project	Breadth of QEQ becomes 130 m. Area is not sufficient compared with quay length.	Breadth behind quay is enough for container handling. Provides space for various port activities.
Construction	Before reclamation, construction of NNP#3/#4 and narrowing of north channel are neccessary.	Free to start construction.
Cost	rate=1.0	rate=1.17

Presently, we assume that the development of the port of Galle is very likely. This will enable Galle port to handle transshipment cargo in a few years after 1995. Thus, the needs for the construction of a new QCT will be reduced.

At the same time, the construction of the port of Galle will take a lot of money.

This may cause financial difficulties if the construction works at the port of Colombo are executed at the same speed.

In addition, charges in transshipment patterns may occur even in a short term period.

Thus we prefer not to select one plan but to show several possibilities. The port master plan shall be reviewed in 1993/1994 when there is sufficient data to judge the best direction for the development.

Fig. 6-3-1 (1)

MASTER PLAN (A)

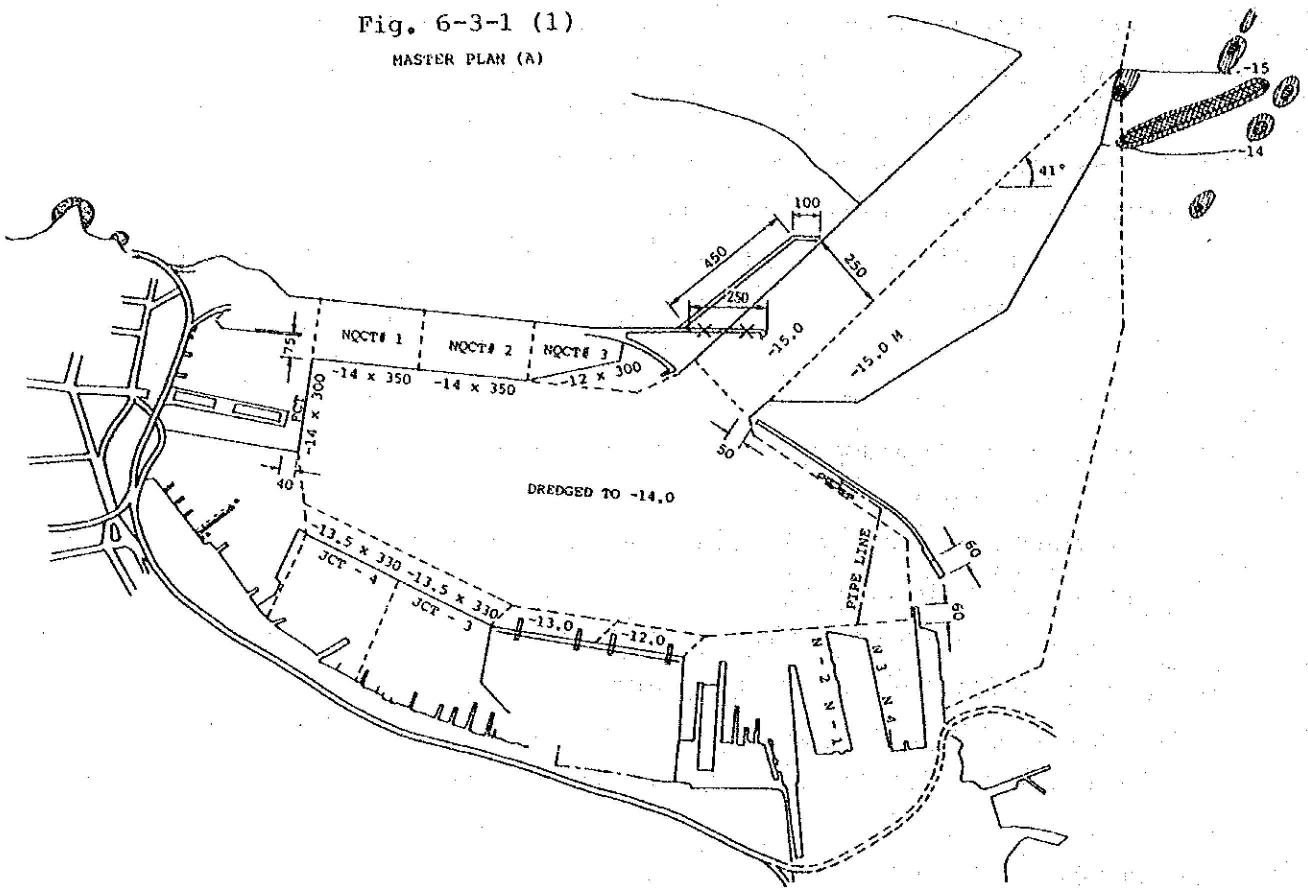
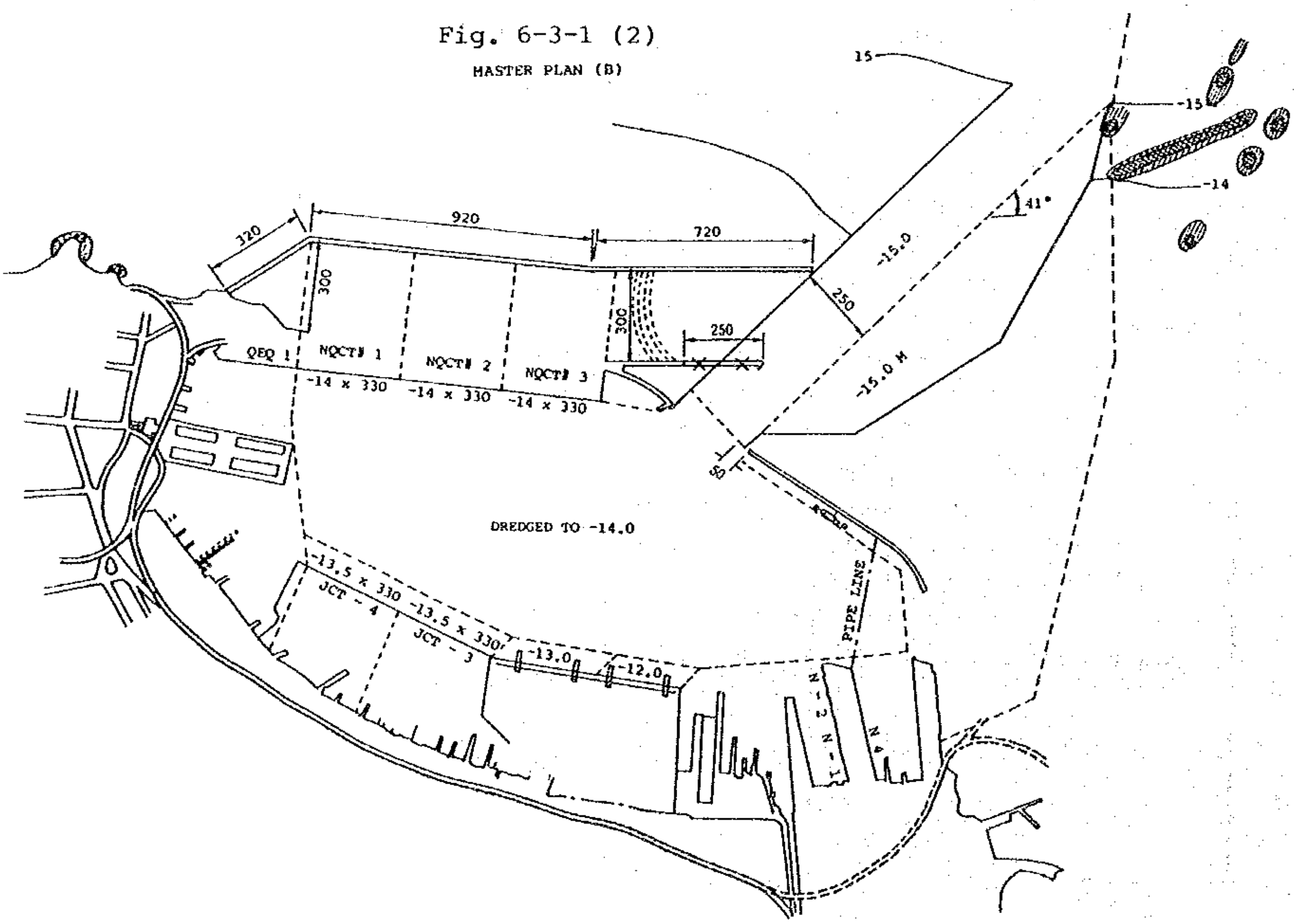


Fig. 6-3-1 (2)

MASTER PLAN (B)



6-3-2 Planned Facilities

(1) Access Channel and Breakwater

The main channel will be improved to increase safety and maneuvability for large vessels (see the ship maneuvability test at appendix 6-3-2-1).

The channel will be widened to 250 m and deepend to -15 m. The alignment will be readjusted to a straight line.

The direction of the channel is set as N 41°W to avoid rock hazardsand the oil pipeline in the excavated channel up to -15.0m.

The locations of rocks were surveyed and confirmed by the study team, and a bathymetry survey was also carried out by the team (see Chapter 3).

The widening and straightening of the channel has some influence on the calmness of the port basin.

The extension of the SW breakwater is planned to maintain the necessary calmness and a sufficient stopping distance (= 5L = 1400 m) for deep draft vessels in the southwest monsoon season.

The proposed breakwater will also be effective to block the sand drift from the south direction.

The breakwater will be fully utilized even after 2001, because the further extension of the breakwater will facilitate the development of the new north port (see Fig. 6-3-2).

The extension of the SW breakwater was planned bearing in mind the future development beyond the year 2001 and taking into consideration the calmness of the port.

As for the narrowing of the north entrance, this is planned in

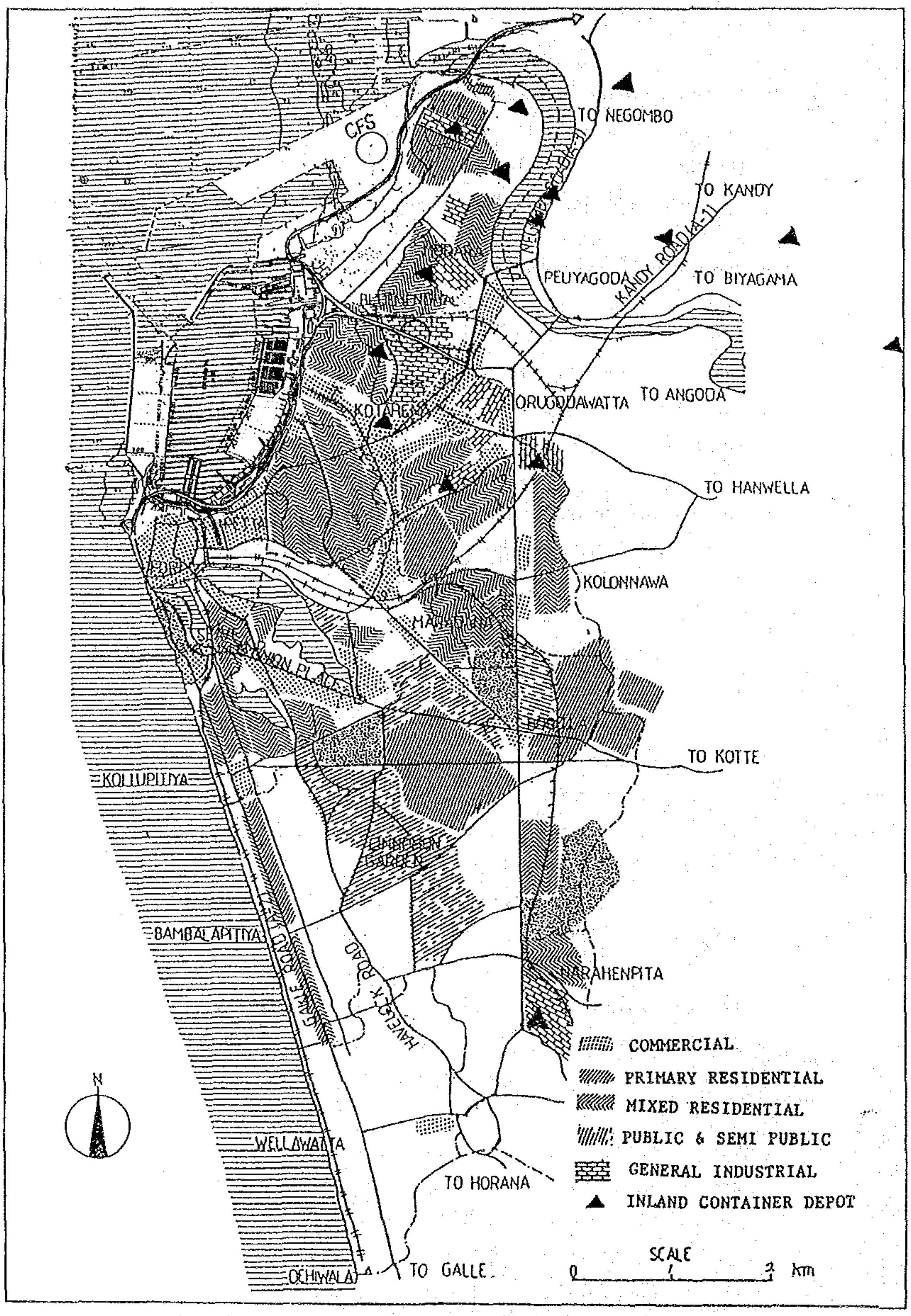


Fig. 6-3-2 Land use in Municipal Area and Concept of the Future Development of the Port

order to ensure a calm basin at the NP wharves (for Plan-A).

This small modification of the north entrance will not adversely affect the water clearness.

Although it will become impossible for large vessels to use the north exit, this is compensated for by the widening of the main channel.

Concerning the calmness of the basin, JCT #2 will become less calm, but the influence on cargo handling will not be significant (see sec 6-3-3).
A hydraulic model test was carried out by the Lanka Hydraulic Institute to confirm the calmness of the basin and to identify problem areas. The results are under examination.

The final decision on widening the entrance and straightening the channel by extending the SW break water shall be made before the arrival of large container ships and the oil tankers.

(2) Port Basin

Most of the basin inside the port will be dredged up to -14 M to accommodate design vessels.

Many large ships will call at the port in 2001. This will make it difficult to provide sufficient waiting areas inside the port.

When there is a strong demand for a waiting area, the extension of the SW Breakwater and the construction of a new island breakwater will be considered.

The study team, however, does not include the further construction of the breakwater in the master plan.

(3) Berths

The locations of the berths are indicated in Fig. 6-3-1. A total of 7 - 8 full-scale container berths are planned.

For break bulk cargo, there will be 9 - 10 deepwater berths available. Dry bulk cargo will be handled at the foot of Prince Vijaya quay and at New North Pier.

Petroleum Oil will be handled at the dolphin berth inside the port and the Single Point Mooring Buoy outside the port.

Coconuts oil will be handled at South Pier as same manner as present.

For small vessels, the Pettah area and Beira channel will be available.

The berth names, berth dimensions, cargo types and target volumes are shown in Table 6-3-2.

Calmness in front of varrious wharves is calculated based on the wave deflection theory.

The method applied and the calculated results are presented in detail in section 6-3-3.
Under the new master plan, all the berths will be used practically through the year without stopage.

Berth dimensions are determined considering;

1) Present condition of Colombo Port, and

2) Future trend of vessel type and size.

Generally speaking, there are hard rock heads at -12 ~ - 16 m in the harbour basin.

The dredging work at the port basin has been carried out by SLPA and half of the port basin has been deepened up to -13 m.

Table 6-3-2 (1) Berths and Handling Capacity Plan-A

Name of Berth	Size (m)	Containers (TEUs)	Break Bulk (Tons)	Dry Bulk (Tons)	Liquid Bulk (Tons)
NQCT #1	-14x350	250,000			
NQCT #2	-14x350	250,000			
NQCT #3	-12x300	250,000			
FCT	-14x300	150,000	150,000		
NBQ #1	-10x185		300,000		
NBQ #2	-10x185		300,000		
JCT #1	-12x300	300,000			
JCT #2	-13x332	300,000			
JCT #3	-13.5x330	300,000			
JCT #4	-13.5x330	300,000			
NNP #1	-7.5x130		250,000		
NNP #2	-11x210			600,000	
NNP #3	-11x200		250,000		
NNP #4	-7.5x130			600,000	
PVQ #1	-9.5x150		250,000		
PVQ #2	-8.0x135		180,000	150,000	
CB #1	-5.0x70		100,000		
CB #2	-5.0x70		100,000		
GP #2	-9.5x150		150,000		
S pier					100,000
Dolphin	-14x185				2,000,000
SPMB	-29				2,000,000
Total Capacity		2,100,000	2,030,000	1,350,000	4,100,000
Forecast Volume		1,730,000	2,020,000	1,240,000	3,150,000

Table 6-3-2 (2) Berths and Handling Capacity Plan-B

Name of Berth	Size (m)	Containers (TEUs)	Break Bulk (Tons)	Dry Bulk (Tons)	Liquid Bulk (Tons)
NQCT #1	-14x330	300,000			
NQCT #2	-14x330	300,000			
NQCT #3	-12x330	300,000			
QEQ #1			100,000		
BQ #1,#2,#2',			650,000		
BQ #3,#4			500,000		
JCT #1	-12x300	300,000			
JCT #2	-13x332	300,000			
JCT #3	-13.5x330	300,000			
JCT #4	-13.5x330	300,000			
NNP #1	-7.5x130		250,000		
NNP #2	-11x210			600,000	
(NNP #3)					
(NNP #4)				600,000	
PVQ #1	-9.5x150		250,000		
PVQ #2	-8.0x135		130,000	300,000	
CB #1	-5.0x70		100,000		
CB #2	-5.0x70		100,000		
GP #2	-9.5x150		150,000		
S pier					100,000
Dolphin	-14x185				2,000,000
SPMB	-29				2,000,000
Total Capacity		2,100,000	2,230,000	1,500,000	4,100,000
Forecast Volume		1,730,000	2,020,000	1,240,000	3,150,000

Thus the study team assumes that a -14 m depth is practically applicable.

As for the future trend of the size of vessels, container vessels, general cargo vessels, and oil carriers with less than -12.5 m draft will be economical and will be used throughout the world (See Appendix 6-2-5).

Thus the maximum depth of the basin is planned to be -12.5 x 1.1 = -14 m.

(4) CFS and Warehouses

1) CFS for domestic (export and import) cargo

Presently, the CFS for domestic (export and import) cargo are located at QCT, JCT, and outside the Port.

Locating the CFS outside the port has no demerits as far as smooth road connections and customs services are available. Considering this situation and the shortage of available space at the port, the new CFS for domestic cargo should be located outside the port wherever possible.

As it is estimated that the total area needed for CFS in 1995 is 48,000 m^2, an additional 21,000 m^2 of CFS must be supplied.

As the CFS sites shall also require container stacking yards and ancillary facilities, the land requirement for the CFS is around 12 m^2/CFS m^2 according to past experience. Thus in 1995, the demand for CFS sites is 12 x 21,000 = 252,000 m^2.

Although the study team is not of the opinion that all of the area should be provided by SLPA, it is necessary for SLPA to help the private sector to acquire land in order to secure the smooth container flow.

As SLPA has pointed out, the study team also thinks it is important to utilize the Bloemendhal area.

The merits of the Bloemendhal area are as follows.

a. very near to the port
b. close to the new port highway
c. close to the railroad
d. convenient to all customers
e. economical to acquire, and
f. no conflict with the land use plan of Colombo city.

Since the available space in the Bloemendhal area is getting smaller day by day, it is advisable to acquire the land as early as possible (a layout plan is shown in Fig. 6-5-22).

In 2001, a total of 79,000 m^2 of CFS is required of which 48,000 m^2 is required by 1995. The remaining demand from 1995 - 2001 is 79,000 - 48,000 m^2 = 31,000 m^2.

This means, the land requirement is 12 x 31,000 m^2 = 372,000 m^2. Although it is difficult to determine to what extent the port should take the initiative, the port should at least reserve some area.

A possible site is indicated in Fig. 6-3-2.

2) CFS for transshipment cargo

The required area for the CFS for transshipment cargo is estimated as 5,000 m^2 in 2001.

The CFS for transshipment must be located inside the port.

The 9,000 m2 Kochchicade warehouse will meet all the demand through 2001.

3) Warehouses

The area necessary for warehouses at NP wharf is estimated as 6,500 m^2 per berth. This is based upon the past perfomance at Bandranaike Quay.

The space between the warehouses and the quaywall should be wide enough for trucks and forklifts to handle cargo freely.

From this point of view, the apron space was planned to be more than 25 m in width.

(5) Roads

SLPA has a port trunk road which runs parallel to the sea shore inside the wall. Most of the road is 4 lanes wide and paved. SLPA also plans to construct a new highway to Weragoda. This highway will open by 1993.

Presently, the only bottleneck is at QEQ.

The possible solutions are:

1) to relocate the repair yard at QEQ.
2) to demolish the QEQ warehouses.
3) to reclaim the fort area, or the seaside of QEQ.

After 1995, there will be considerable traffic congestion in the Colombo urban area.

The port vicinity will be the most crowded area if proper countermeasures are not taken.

Among the possible places of heavy traffic, the vicinity of Baghdad gate will be the worst. In order to avoid congestion in front of Baghdad gate, it is necessary to reduce the traffic flow by permitting cars to use the port highway.

Thus the concept of an overpass and a 'Baghdad - Fort' - 'Buddha Jayanthi Chaitiya' port highway route was examined.

The image plan of the overpass is shown in Fig. 6-3-3.
The road will be maintained by fees from the outside users. The port highway should not have any exits towards the city center in order to avoid traffic jams.

In other words, general cars shall use the port highway only when they go out of or pass by the city.

After 2001, the port road shall be extended through the north port area to Negombo road (at the Wattala area). (see Fig. 6-3-2)

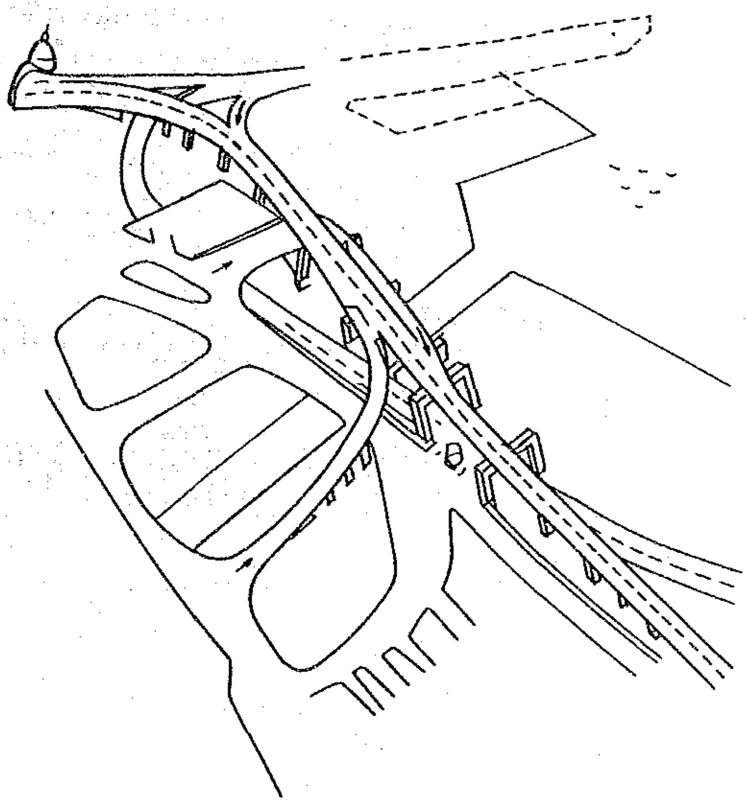


Fig. 6-3-3 Image Plan of Port Highway and Overpass

(6) Computer and Communications System

Computer and communications systems are getting easier to handle, to obtain and to install.

1) The communications system
The communications system shall consist of a wireless system and an on-line system. (See. Fig. 6-3-4)

2) Computer network system
The services (or functions) and the range of users are indicated in Fig. 6-3-5.

Since the SLPA has started computerization, it is desirable to expand the existing system and service and extend user coverage.

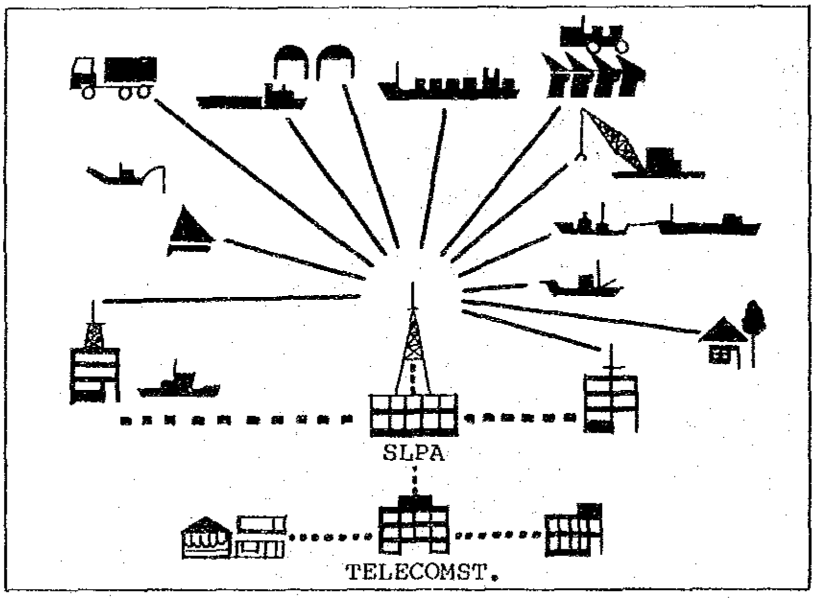


Fig. 6-3-4 Concept of the Communications System

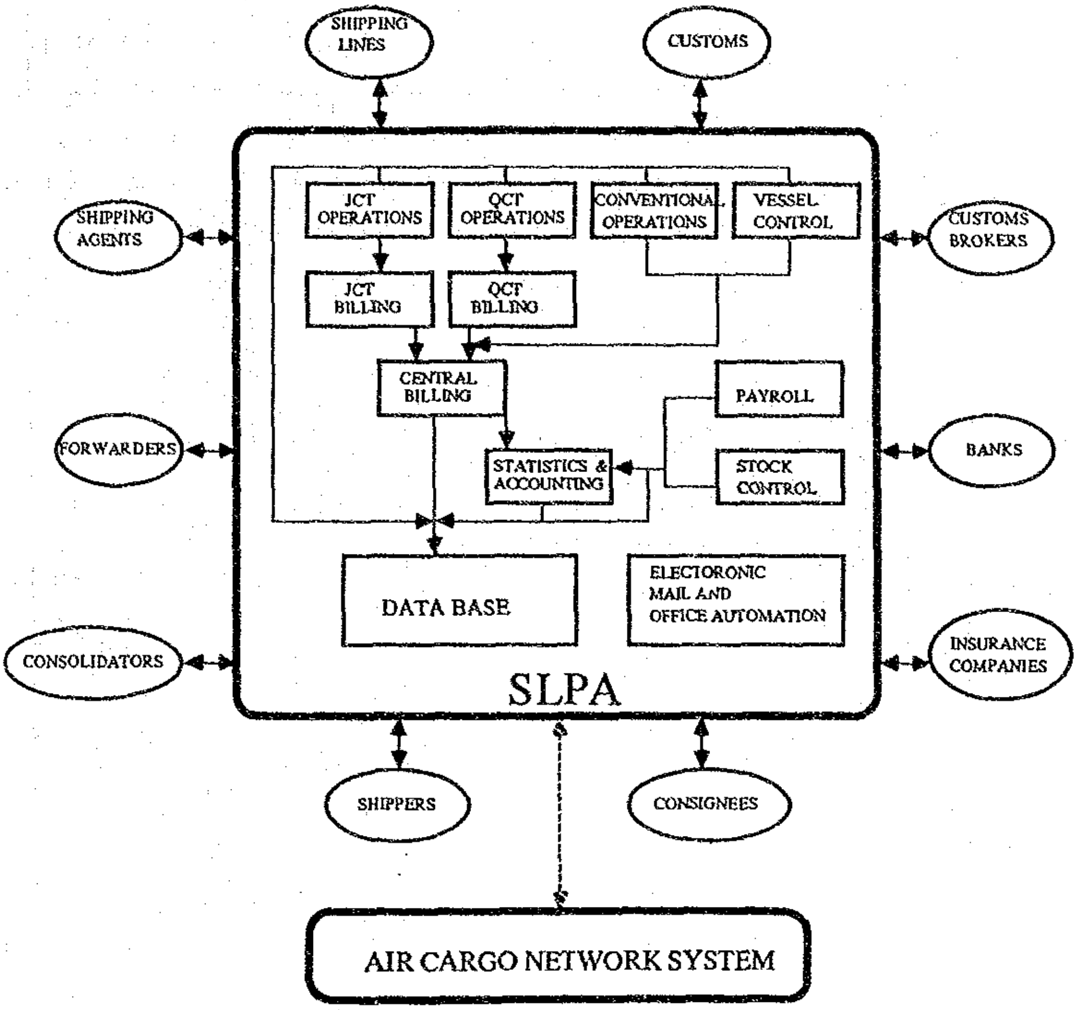


Fig. 6-3-5 Concept of Computer Network System

(7) Navigation Aids

By straightening the entrance channel, it will become much easier to enter the channel.

In this relation it will be necessary to install a minimum of two buoys at the entrance of the channel and two light houses at both sides of the head of the breakwater.

A radar system would also be very helpful, if the ships can have information from the land side. Considering the costs, a radar-computer control system will not be necessary until 2001. However, the rapid progress of communications technology may accelarate the introduction of such a system.

Table 6-3-3 (1) Summary of Planned Facilities

Summary of Plan	Plan-A
1. Access Channel and Breakwater	
1) Access Channel	Direction N 139 ° E Breadth 250 meters Depth -15.0 m
2) Breakwaters	Extension SW breakwater 550 meters Removal SW breakwater 250 meters Removal NW breakwater 50 meters
3) North entrance	Extension NW breakwater 60 meters Extension NE breakwater 60 meters
2. Port Basin	Main basin will be dredged up to -14 meters
3. Berths	
1) Container	NQCT #1 -14x350 NQCT #2 -14x350 NQCT #3 -14x300 FCT -14x300 JCT #3 -13.5x330 JCT #4 -13.5x330
2) Conventional	NNP #1 -7.5x130 break bulk NNP #2 -11x210 fertilizer bulk NNP #3 -11x200 break bulk NNP #4 -7.5x130 cement bulk
3) Oil handling	Pipelines 24"x1 line by cost allocation 12"x4 lines 10"x1 lines 6" x3 lines
4. Bloemendhal area development (Crown Land)	160,000 m^2
5. Roads	QEQ area Port highway to Weragoda Overpass at Baghdad gate
6. Computer and Communications system	
7. Navigation aids	

Table 6-3-3 (2) Summary of Planned Facilities

Summary of Plan	Plan-B
1. Access Channel and Breakwaters	
1) Access Channel	Direction N 139 ° E Breadth 250 meters Depth -15.0 m
2) Breakwaters	Extension SW breakwater 550 meters Removal SW breakwater 250 meters Removal NW breakwater 50 meters
2. Port Basin	Main basin will be dredged up to -14 meters
3. Berths	
1) Container	NQCT #1 -14x330 NQCT #2 -14x330 NQCT #3 -14x330 JCT #3 -13.5x330 JCT #4 -13.5x330
2) Conventional	NNP #1 -7.5x130 break bulk NNP #2 -11x210 fertilizer bulk (NNP #4) cement bulk
3) Oil	Pipelines 24"x1 line by cost allocation 12"x4 lines 10"x1 lines 6" x3 lines
4. Bloemendhal area development (Crown Land)	160,000 m^2
5. Roads	QEQ area Port highway to Weragoda Overpass at Baghdad gate
6. Computer and Communications system	
7. Navigation aids	

6-3-3 Calmness Study

A computer-aided simulation study has been undertaken to determine the impacts which may be produced on the calmness of the inner harbor for five cases of the development plan for the Port of Colombo, including the proposed breakwater extension, reclamation work, construction of container berths, etc.

(1) Layout and Conditions for Computation

1) Frequency of Incident Waves by Height

Table 3-3-3 (1) shows the frequency distribution of deep-sea wave occurrence off the Port of Colombo. These waves vary in height under the influence of depth, refraction, bottom friction and other factors before reaching the opening between the existing breakwaters.
Based on a height of 1.0 to 1.5 m and a period of 5 to 8 sec for the deep-sea waves, the shoaling coefficient and the bottom friction coefficient are estimated at about 0.95 or more. On the other hand, a refraction coefficient of 0.8 is estimated for the NNW waves and for other waves the refraction coefficient is estimated to be 0.95 or more. Figs. 6-3-6 (1) to 6-3-6 (5) show refraction diagrams. Table 6-3-2 gives the frequency of wave occurrence at the harbor entrance determined by modifying Table 3-3-3 (1) in consideration of the height decrease due to wave refraction.

2) Layout

Five layout plans were evaluated primarily on the basis of the Master Plan for Colombo Port the year 2001. The evaluated layout plans are as follows:

(i) Short Term Plan (See Fig. 6-3-8 (1))
- No modification is contemplated for the three

existing breakwaters (Southwest, Northwest and Northeast).

- Construction of JCT Berths No.3 and No.4 and NNP Berth No.3 and No.4 are planned.
- The area between Queen Elizabeth Quay and Bandaranaike Quay will be reclaimed.

(ii) Master Plan A (See Fig. 6-3-8 (6))

Plans for extending the existing breakwater, reclamation and construction of additional container berths are the subject of Master Plan A for the year 2001.

Master Plan A as distinct from the Short-term Plan envisages the following:

- The water area fronting the Queen Elizabeth Quay and the Bandaranaike Quay will be filled and a new quay will be constructed.
- The Southwest Breakwater will be realigned and a new 550 m breakwater will be built.
- A 50 m section of the west end of the Northwest Breakwater will be demolished.
- The Northwest Breakwater will be extended by 60 m from its east end.
- The Northeast Breakwater will be extended by 60 m from its end.

(iii) Master Plan B (See Fig.6-3-8 (11))

This master plan, an alternative to Master Plan A, is aimed at coping with the situation resulting from filling of the area on the west of the Northwest Breakwater. It is distinct from Master Plan A in the following respects:

- Realignment of the Southwest Breakwater
- Demolition of a 60 m section of the east end of the Northwest Breakwater and 60 m section of the Northeast Breakwater end (same as under the Short-

term Plan)

(iv) Future Plan A' (See Fig.6-3-8 (16))

This plan envisages further improvements over Master Plan A. The proposed improvements are as follows:

- The Southwest Breakwater will be extended by an additional 500 m.
- A new 1,400 m breakwater will be built offshore of the Northwest Breakwater.
- Parts of the Northeast Breakwater and of Prince Vijaya Quay will be demolished.

(v) Future Plan B' (See Fig. 6-3-8 (21))

This plan envisages further improvements over Master Plan B. The proposed improvements are as follows:

- The Southwest Breakwater will be extended by an additional 500 m.
- A new 1,400 m breakwater will be built offshore of the Northwest Breakwater (same as under Future Plan A').
- Part of the Prince Vijaya Quay will be demolished (same as under Future Plan A').

3) Reflection Coefficients

The reflection coefficients for the existing and proposed structures are given in Fig. 6-3-7.

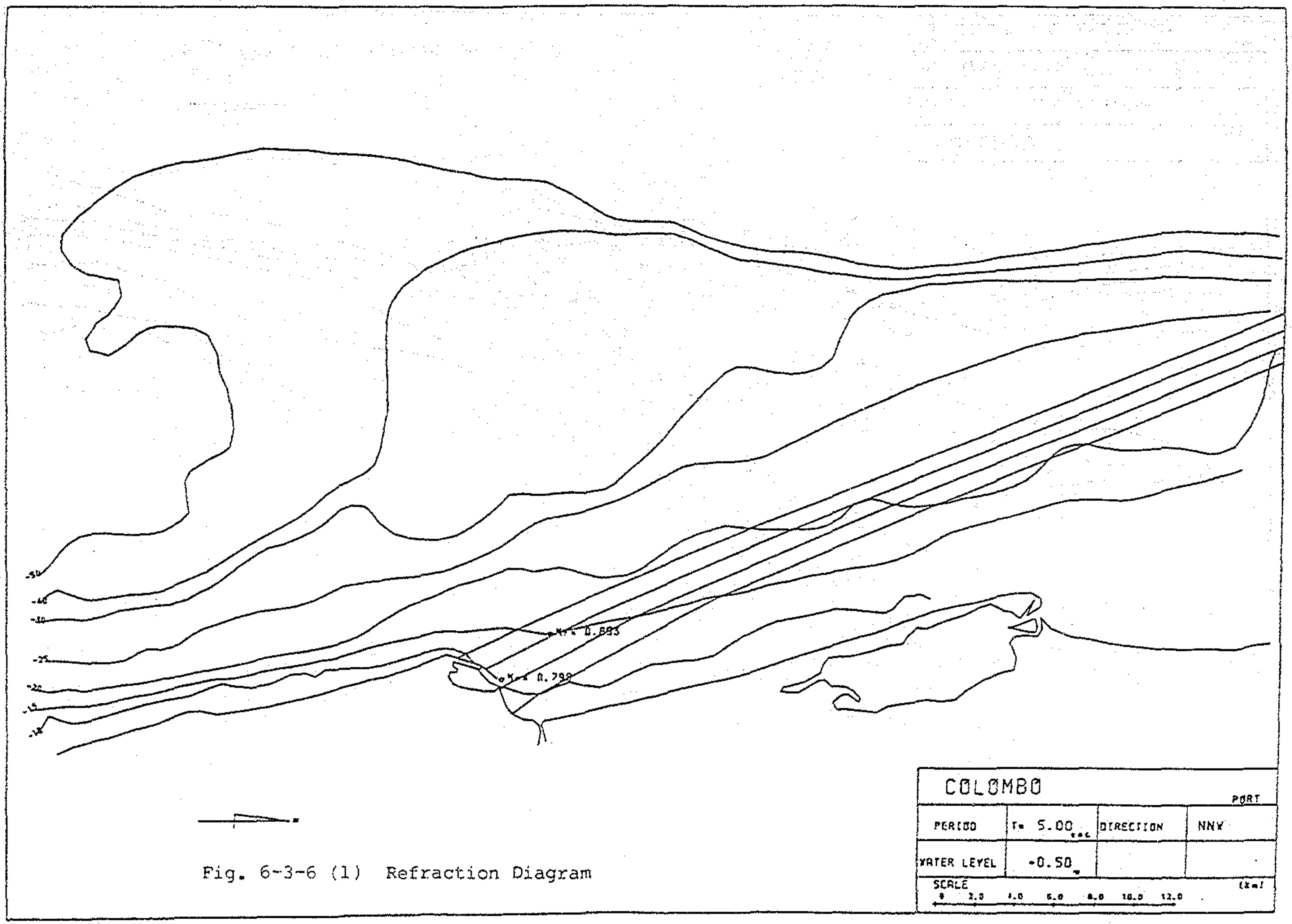


Fig. 6-3-6 (1) Refraction Diagram

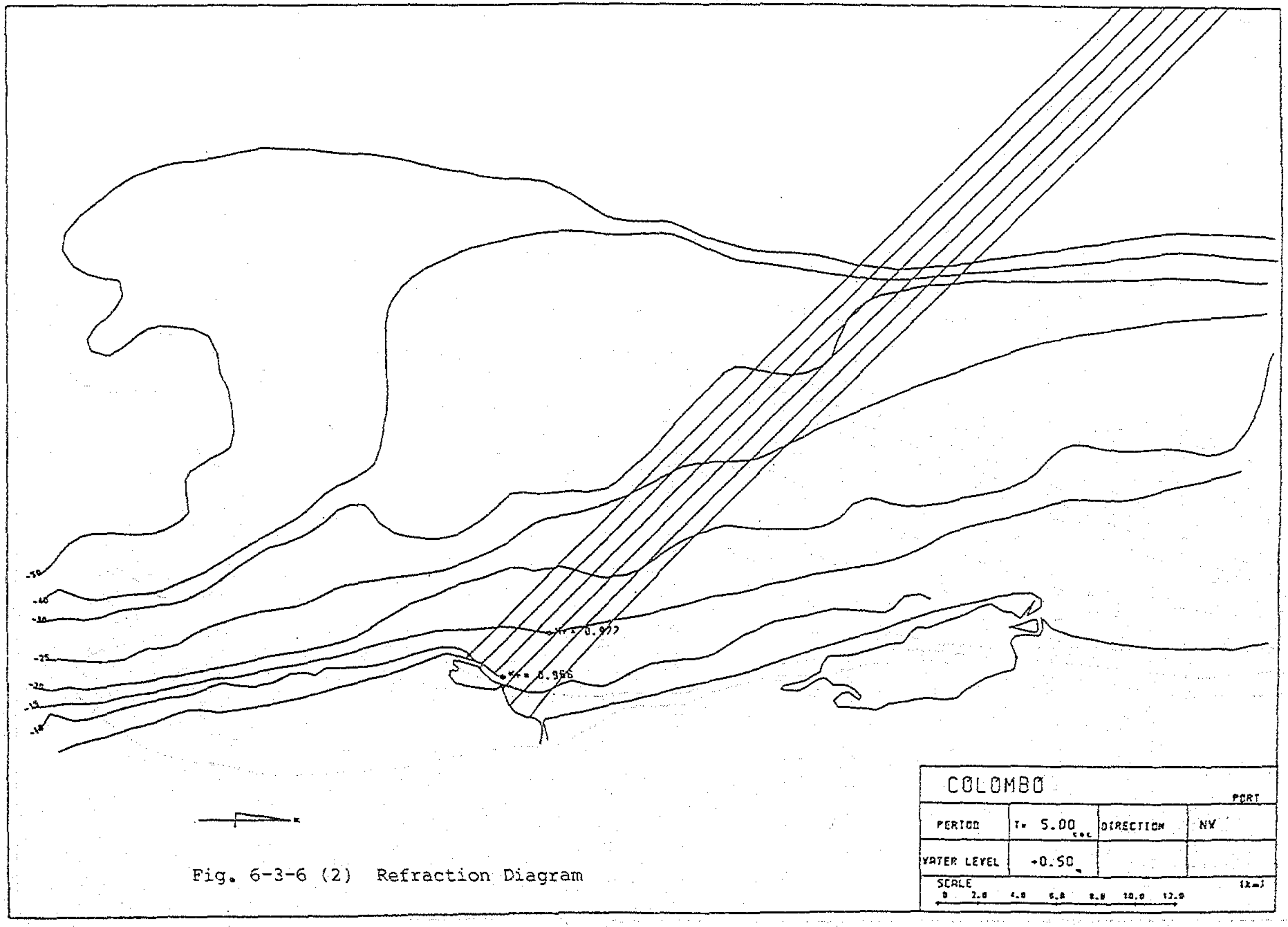


Fig. 6-3-6 (2) Refraction Diagram

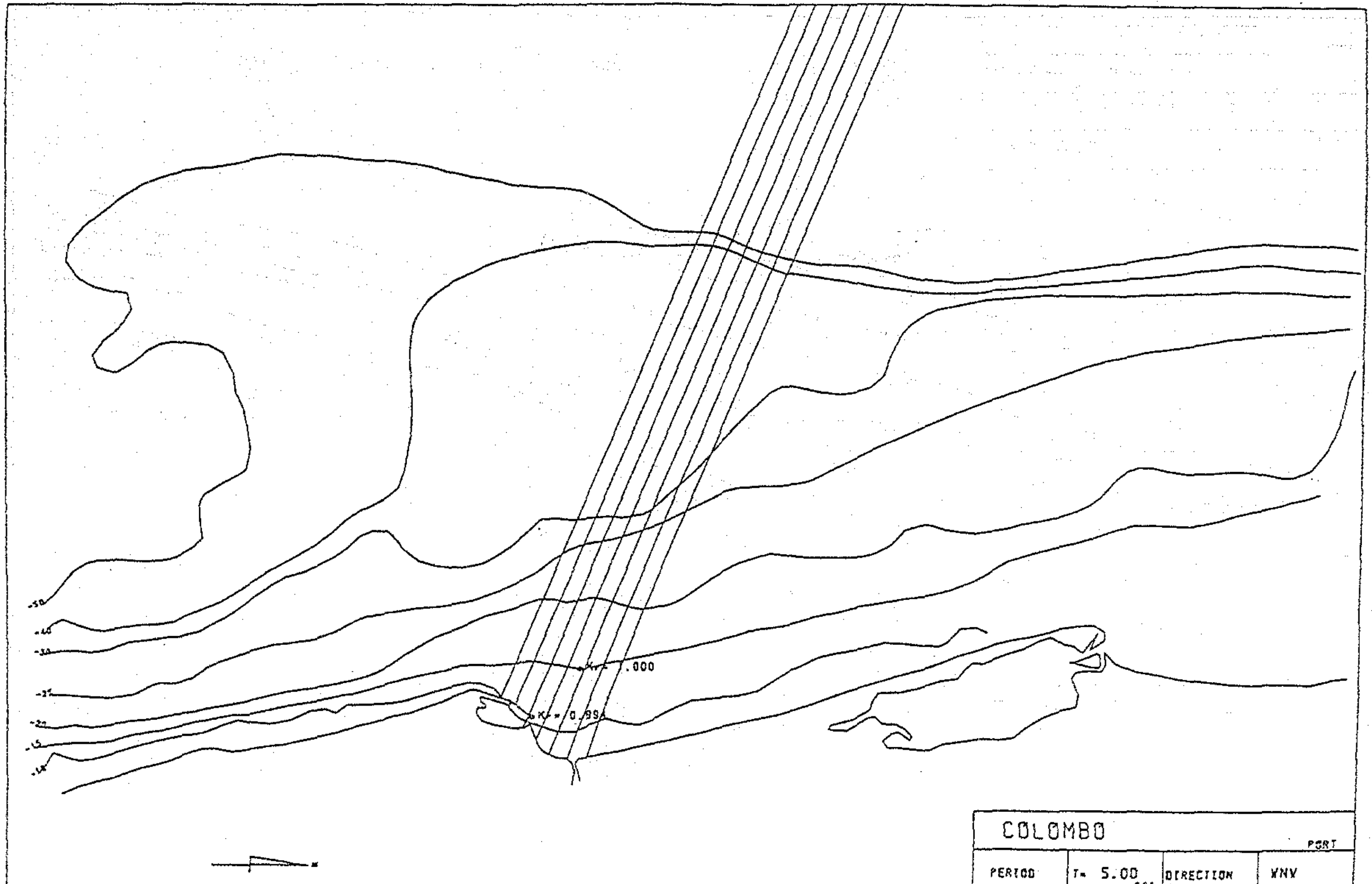


Fig. 6-3-6 (3) Refraction Diagram

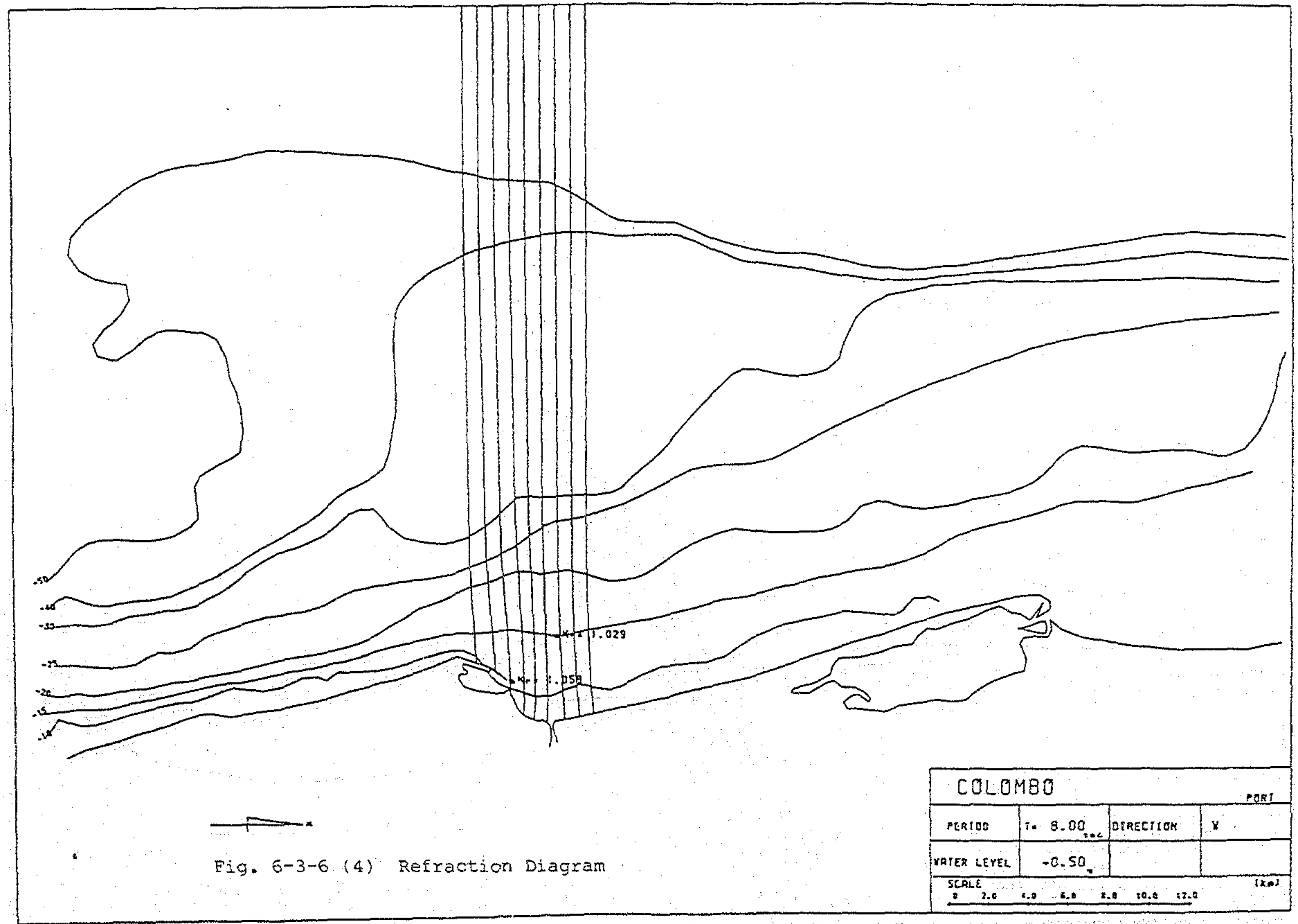


Fig. 6-3-6 (4) Refraction Diagram

Fig. 6-3-6 (5) Refraction Diagram

COLOMBO			PORT
PERIOD	T= 8.00 sec	DIRECTION	WSW
WATER LEVEL	+0.50 m		
SCALE 0 2.0 4.0 6.0 8.0 10.0 12.0 (km)			

Table 6-3-4 Frequency of Wave Occurrence (%) at Entrance of Colombo Port

(annual)

Direction / Wave Height (m)	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.00 - 0.49	2.6 (4.0)	2.2 (10.1)	3.5 (19.1)	5.4 (28.0)	4.9 (15.2)	1.6 (5.1)	2.0 (5.6)	5.8 (13.1)	28.0
0.50 - 0.99	1.2 (1.4)	5.3 (7.9)	8.5 (15.6)	13.7 (22.6)	6.1 (10.3)	2.6 (3.5)	2.4 (3.6)	5.6 (7.3)	45.4
1.00 - 1.49	0.2 (0.2)	1.7 (2.6)	5.4 (7.1)	6.4 (8.9)	2.9 (4.2)	0.6 (0.9)	0.8 (1.2)	1.7 (1.7)	19.7
1.50 - 1.99		0.7 (0.9)	1.1 (1.7)	1.4 (2.5)	0.9 (1.3)	0.3 (0.3)	0.4 (0.4)		4.8
2.00 - 2.49		0.1 (0.2)	0.3 (0.6)	0.6 (1.1)	0.2 (0.4)		0.0 (0.0)		1.2
2.50 - 2.99		0.1 (0.1)	0.2 (0.3)	0.3 (0.5)	0.1 (0.2)				0.7
3.00		0.0	0.1	0.2	0.1				0.4
Total	4.0	10.1	19.1	28.0	15.2	5.1	5.6	13.1	100

Note: Percentage Exceedence in Brackets

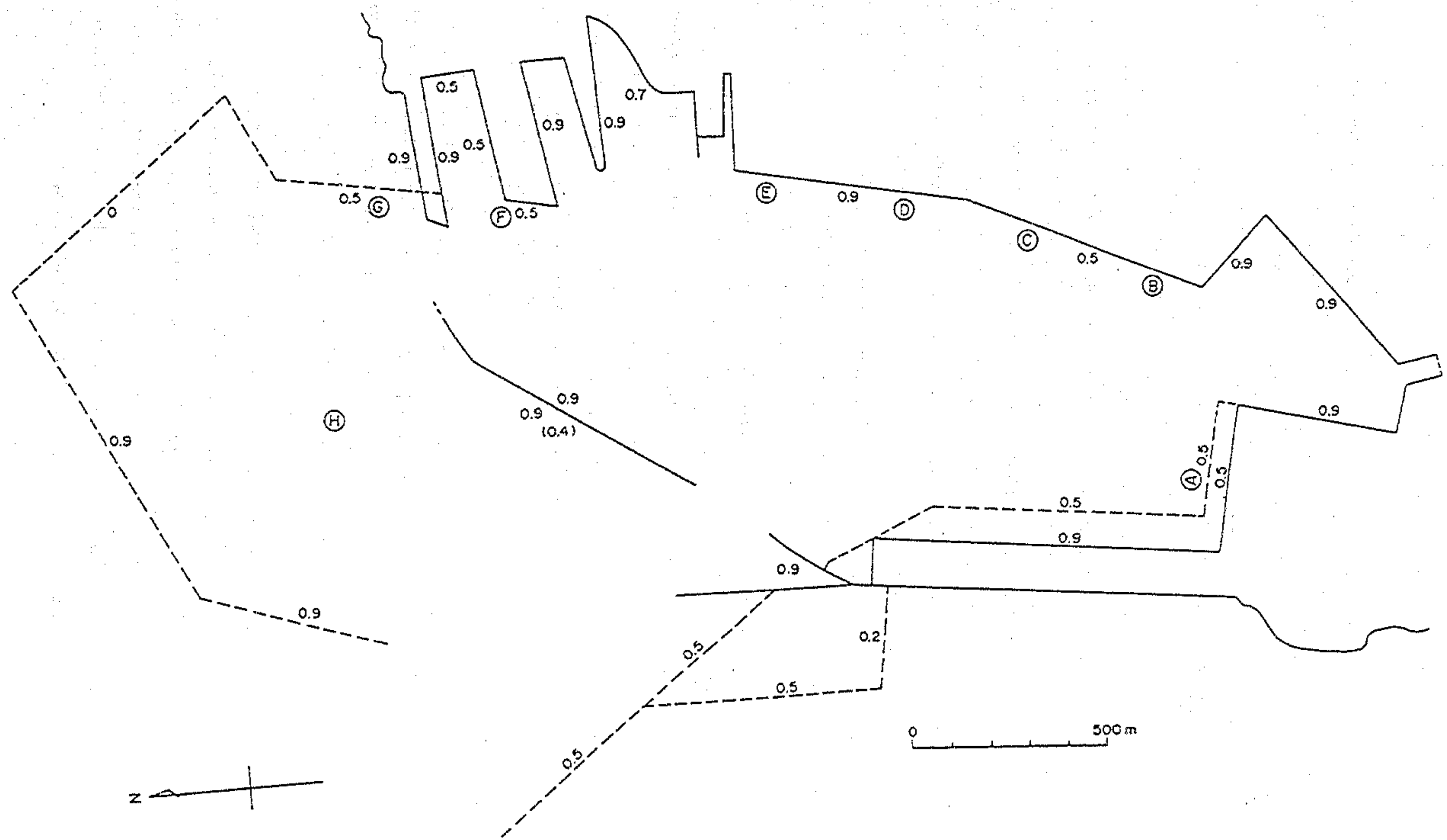


Fig. 6-3-7 Reflection Coefficient

(2) Wave Height Ratio for the Port

Fig. 6-3-8 (1) to Fig. 6-3-8 (25) illustrate the contour lines of the wave height ratio obtained for the Port of Colombo from computerized simulation analyses.

(i) Short Term Plan

In this situation, the calmness of the harbor basin is affected most by NNW waves. Incident waves entering from the harbor entrance advance straight to the innermost part of the harbor and attain a wave height ratio of slightly less than 0.5 in front of JCT Berth No.3 and Berth No.4. The wave height ratio for the area in front of JCT No.1 and No.2 Berths is slightly over 0.5 due to the impacts of waves entering from the North Harbour Entrance and the impacts of reflected waves produced by the vertical type quay structure. The ratio is less than 0.3 for the Queen Elizabeth Quay and Bandaranaike Quay areas.

In front of the North Pier, the wave height ratio reaches 0.8 because of incoming waves from the North Entrance. However, the impacts of these waves on the calmness of the basin will be limited to the area adjacent to the North Entrance.

With respect to NW waves, the wave height ratio is 0.5 for the JCT No.2 Berth area, but decreases to 0.4, a smaller value than that relative to NNW waves, for the JCT No.1, No.3 and No.4 Berth area.

As the wave direction shifts toward the west, the sheltering effects of the Southwest Breakwater will become noticeable. As a result, the harbor basin will become calm with the wave height ratio reduced to less than 0.3 with respect to W waves except in the areas adjacent to the Main Entrance and the North Entrance.

(ii) Master Plan A

The proposed extension of the Southwest Breakwater will not provide sheltering effects with respect to NNW waves. The wave height ratio for the area fronting the JCT No.3 and No.4 Berths will be increased to a value slightly less than 0.6 as against 0.5 under the Short-term Plan, because of the widened harbor entrance as a result of the demolition of the end of the Northwest Breakwater. For the area in front of the Queen Elizabeth Quay structure, the wave height ratio is nearly 0.3, a value slightly larger than under the Short-term Plan.

In that part of the harbour basin fronting the North Pier, on the other hand, the wave height ratio decreases to 0.4 or 0.5 because of the effects produced by the narrower North Harbour Entrance as a consequence of the proposed extensions of the Northwest and Northeast Breakwaters. These same effects will also spread to the JCT No.1 Berth area where the wave height ratio will be 0.4, or 0.1 less than that under the Short-term Plan.

As in the Short Term Plan, with the shift of the wave direction toward the west, the sheltering effects of the extended Southwest Breakwater will begin to be felt. The wave height ratios for the JCT No.3 and No.4 Berth areas are 0.5, 0.35, 0.2 and 0.1 with respect to NW, WNW, W and WSW waves, respectively.

(iii) Master Plan B

Under this plan, the tips of the breakwaters on both sides of the Main Harbour Entrance will be found at the same positions as under Master Plan A and in the area inside the new breakwater, waves will be dissipated. For these reasons, the effects of diffracted waves in the basin under Master Plan B will be much the same as under Master